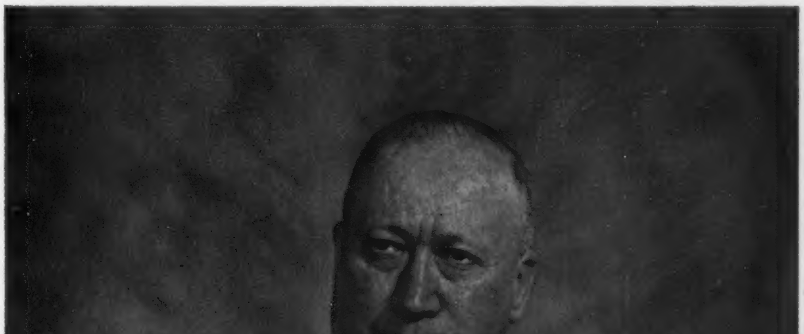
OFFICIAL PUBLICATION

JOURNAL

Heating • Refrigerating • Air Conditioning • Ventilating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS



John Everetts, Jr., succeeded Robert H. Tull as President of ASHRAE at the 68th Annual Meeting in Denver. His message to members appears on page 58.

JULY 1961

JULY 1961

VOL. 3 NO. 7

ASHRAE OFFICIAL PUBLICATION

JOURNAL

Formerly Refrigerating Engineering including Air Conditioning, and incorporating the ASHAE Journal.

Cover photo by Luedecke Studios

FEATURE

NEWS

DEPARTMENTS

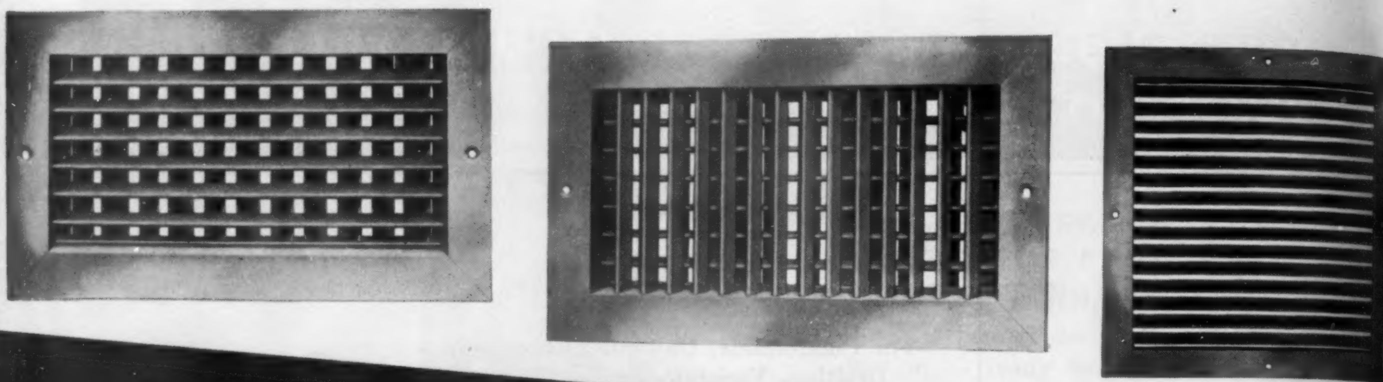
Member
Audit Bureau of Circulations

Published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
Editorial and Circulation Offices, 234 Fifth Avenue, New York 1, N. Y. MUrray Hill 3-6496
Advertising Offices, 62 Worth Street, New York 13, N. Y. BArclay 7-6262
Midwest Advertising Office, 35 East Wacker Drive, Chicago 1, Ill. Financial 6-7255
Southern Advertising Representative, James C. Crawford, 921 Fulton Federal Building, Atlanta, Ga. JAckson 2-9769
Western Advertising Representative, Chris Dunkle & Associates, 420 Market Street, San Francisco 11, Calif. SUtter 1-8854
740 South Western Avenue, Los Angeles 5, Calif. DUnkirk 7-6149

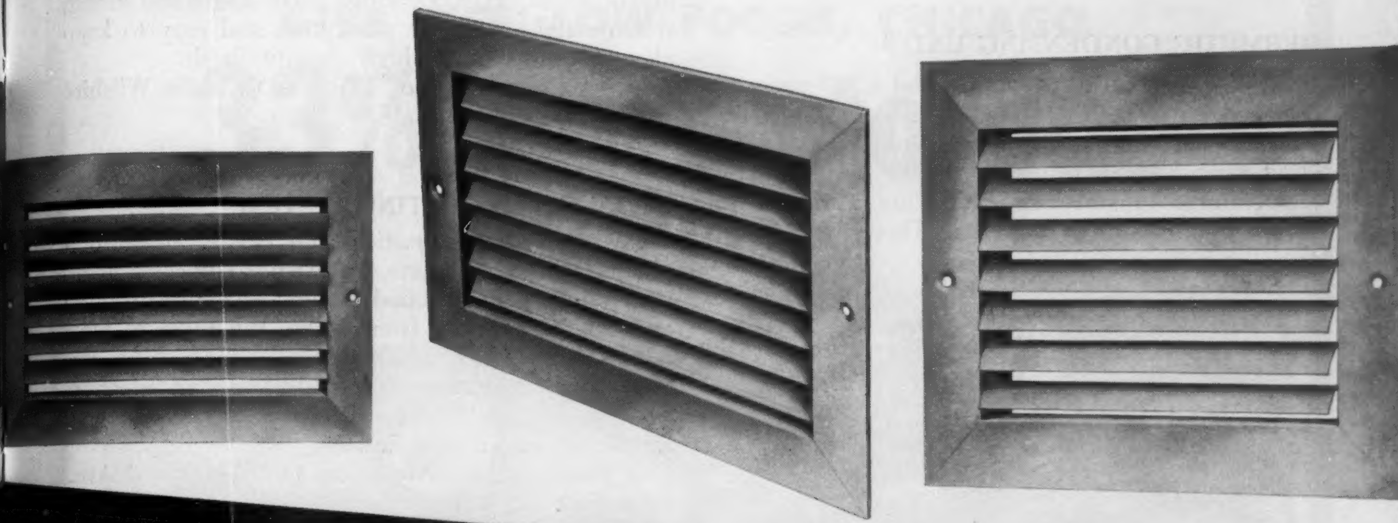
Price by subscription, $5.00 1 yr.; $8.00 2 yr.; $10.00 3 yr. in U.S.A. and Canada. $2.00 per yr. additional in other countries (payable with order). Single copies (payable with order) 75c; 6 months old or more $1.00; 5 yr. old or more $1.50. Published monthly.
Volume 3 includes the January through December 1961 numbers.

Second Class Postage paid at East Stroudsburg, Pa. Postmaster: On undeliverable copies send Form 3579 to ASHRAE JOURNAL, 234 Fifth Avenue, New York 1, N. Y.

Hughes Printing Company, East Stroudsburg, Pa.



STANDARDLINE



...EXTRUDED ALUMINUM GRILLES AND REGISTERS

STRONG

Tuttle & Bailey STANDARDLINE grilles and registers have *all* parts of extruded aluminum . . . far stronger than rolled aluminum and impervious to rusting, pitting, corrosion . . . even in salt air. You can count on STANDARDLINE units to retain a "just-installed" appearance.

EASILY COLOR-MATED

STANDARDLINE surfaces are etched to a rich lustre and coated a clear acrylic acid. The fine finish is handsome as is, or serves as an efficient base for color-matching grilles and registers to any decor without fear of "bleed-through" or need for a prime coating.

FOR EVERY INSTALLATION

T&B offers a *complete line* of grilles and registers designed to fill the bill for every job . . . commercial or residential . . . and in any climate.

For more information, call your nearest T&B Representative or write us direct.

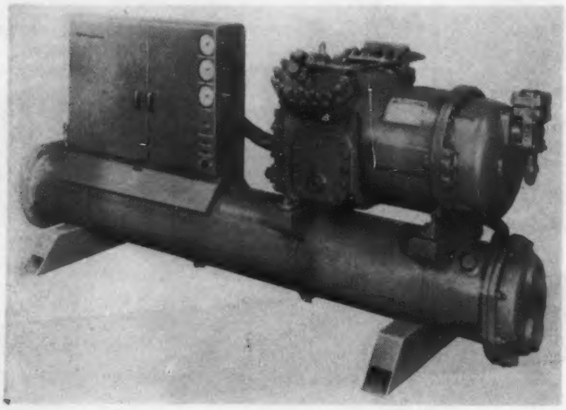
TUTTLE & BAILEY

Division of Allied Thermal Corporation
New Britain, Connecticut
Tuttle & Bailey Pacific, Inc., City of Industry, Calif.

PARTS AND PRODUCTS

HERMETIC CONDENSING UNITS

In ratings from 20 to 60 ton, Model CNU units are designed for use in field assembled commercial and industrial air conditioning equipment. Suction operating temperatures from 20 to 50 F are standard; temperatures outside this range are available for special applications as required. There are six volt-



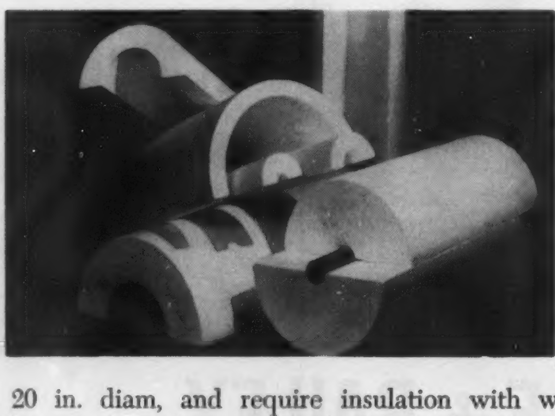
age ratings at three phase, 60 cycle (208, 220, 240, 440, 480 and 550) and three at three phase, 50 cycle (220, 380 and 400).

Each condensing unit consists of a water-cooled condenser, a hermetic compressor and a control center. Starters, safety controls, gauge panel and all internal control and power wiring between control center and compressor are included as standard items. All units are equipped with either line-start or part-winding-type starters and with quick-trip overload relays.

Westinghouse Electric Corporation, Air Conditioning Div, P. O. Box 510, Staunton, Va.

PIPE INSULATION MOLDS

Pipes that carry ammonia, brine, halogenated hydrocarbon refrigerants and water for systems which maintain low temperatures come in sizes from ¼



to 20 in. diam, and require insulation with wall thicknesses from ½ to 20 in. Many combinations of size and wall thickness may be required. A series of molds, which can produce foamed plastics pipe covering in an extensive range of sizes and wall thicknesses, has been developed for use with Dylite expandable polystyrene. This foamed plastics is cited as having an insulative value exceeding that of cork and other materials previously used. Light and strong, it is resistant to water absorption and easy to keep clean because of its high density finish.

Koppers Company, Inc., Plastics Div, 3450 Wilshire Blvd., Los Angeles, Calif.

CEILING VENTILATING SYSTEM

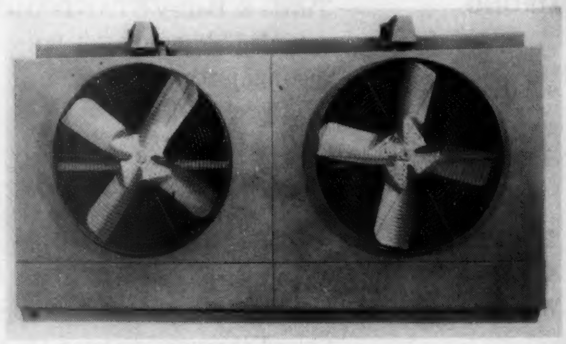
Using suspended acoustical tile ceiling to form a plenum, the Vent-Spline, an extruded plastics member, provides a controlled method of air distribution and can be adjusted from within the room to form various air distribution patterns. Permitted by this system are freedom of acoustical tile design selection, freedom of partition and furniture relocation and freedom from air stratification.

Elof Hansson, Inc., Acoustical Div, 711 Third Ave., New York 17, N. Y.

COOLING TOWER

Now offered is a new economy model cooling tower with horizontal double-fan discharge. Nominal rating of the EC-120 is 120 ton, based on a capacity of 360 gpm of water at 95 F entering water temperature, 85 F leaving water temperature and 78 F wet bulb temperature.

Double fans draw air from the open back of the



tower through the wetted deck surfaces and provide greater efficiency through more even air distribution. Normally provided with weatherized cabinets made of electrically-welded, 14-gauge steel, the EC-120 may be ordered with 10-gauge steel housing when desired for applications requiring extra heavy duty construction.

Halstead & Mitchell Company, Bessemer Bldg., Pittsburgh 22, Pa.

SMALL CONTACTORS, STARTERS

Smaller contactors and starters in Nema Sizes 3 and 4, cited as offering reductions in panel space requirements up to 25% in the critical height dimensions, have been added to 100-Line controls. Both open

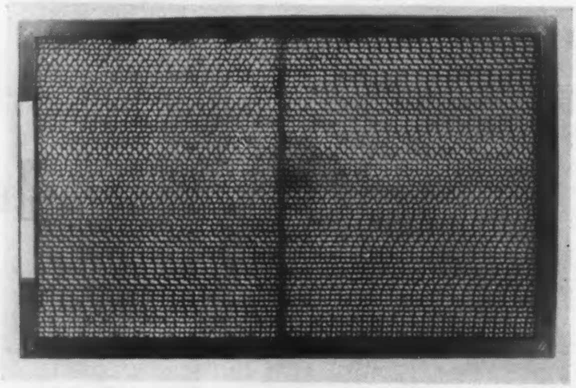
and enclosed forms are available and connections for all new forms are made in front. Installation is speeded by solderless pressure-type terminals and separate terminal posts that accept crimp-on ring connectors.

On Size 3 units, the arc chute design consists of a magnetic steel trap which exhausts ionized gases; arcs are contained and quenched. On Size 4, the arc is broken by metal grids embedded in an arc-extinguishing compound. Bimetallic overload relays are used on both. Size 3 units are rated for control up to 50 hp, 600 volt; Size 4 to 100 hp, 600 volt.

General Electric Company, One River Rd., Schenectady 5, N. Y.

DISPOSABLE FILTERS

Disposable odor remover filters consist of a gridwork of activated charcoal-coated fiber strips assembled in



a paperboard frame. Used in forced air ventilating systems, the units are light in weight, have a low resistance to air of 0.04 at 300 fpm and are installed easily. Standard sizes are available with or without dust media.

Barnebey-Cheney Company, Cassady at Eighth Ave., Columbia 19, Ohio.

AUDITORIUM VENTILATOR

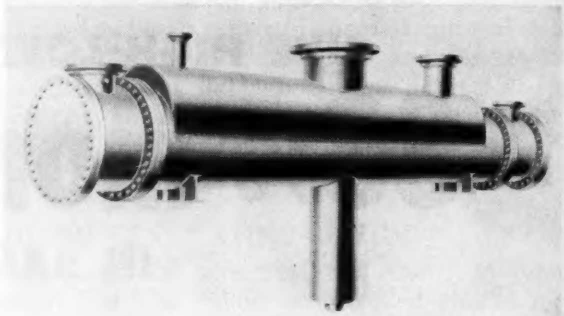
Redesigned, the Audivent incorporates characteristics of Herman Nelson Classroom Unit Ventilators, in sizes to suit applications in the more public areas of a school, such as auditoriums and cafeterias. Available for steam, hot water or electric applications, the units feature quiet operation. Sound attenuators have been added and the ventilators lined with one-in. glass fiber insulation, bonded with a thermo-setting plastics resin. Also featured are enclosed motor and drive, now within the cabinet and accessible through hinged doors. Nine sizes are offered in the low and seven in the high pressure ranges.

American Air Filter Company, Inc., 215 Central Ave., Louisville 8, Ky.

SURFACE CONDENSER LINE

Covering a range from 200 to 10,000 sq ft, the new S-1000 line of single bank, balanced flow surface condensers is built from standard, pre-engineered components. Adaptability is to small turbine drives used in such applications as centrifugal compressors in air conditioning, pump or blower drives and stand-by units.

Pre-engineered components provide a broad de-

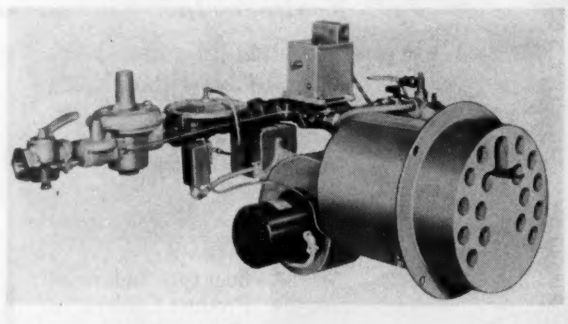


sign flexibility that permits selection of shell diameters (15 through 48 in.); any practical tube length; two tube sizes (5/8 and 3/4 in.); one, two or four-pass arrangements; and six water box design pressures (30 through 300 psi). Other features are low pressure loss through the condensing bank, large entrance area to the tube bank and balanced flow within the bundle. Units are designed for working temperatures of 150 F. Shells are reinforced to withstand operation under 30 in. Hg vacuum or 15 psig pressure.

American-Standard, Industrial Div, Detroit 32, Mich.

POWER GAS BURNERS

Now available in two types, Lo-Blast burners are offered as Model L, with square wind boxes and a capacity range from 350,000 to 6,000,000 Btu/hr, and Model K, with a flange-mounted, cylindrical burner box with built-in refractory face and capacities from



200,000 to 6,000,000 Btu/hr. Also redesigned, three models of Economite burners cover a range from 75,000 to 800,000 Btu/hr.

Mid-Continent Metal Products Company, 2717 N. Greenview Ave., Chicago 14, Ill.

ROOF MOUNTED CONDITIONERS

Three new models, 1109-00, 1112-00 and 1116-00, have nominal capacities of 7½, 10 and 15 ton, respectively, and are designed for applications requiring cooling only, heating only or year-round air conditioning. Combinations possible with these three units include: packaged air conditioning; packaged heating and cooling with either stainless or aluminized steel heat

Phelps Dodge Copper Products Corp.
Dept. F-1, 300 Park Ave., New York 22, N.Y.

Please send me your new wrot fittings catalog.

Name________________________________

Firm________________________________

Street Address________________________

City________________________________

State_______________________________

AIR-CONDITIONING AND REFRIGERATION WHOLESALERS
A-R-W
ASSOCIATE
MEMBER

Quality tube and fittings sold the quality way—through authorized refrigeration wholesalers!

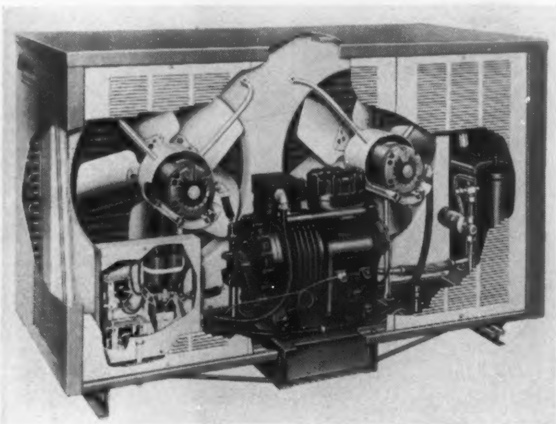
PHELPS DODGE COPPER PRODUCTS
CORPORATION
300 Park Avenue, New York 22, N. Y.

P D MINE TO MARKET

exchangers on gas-fired furnaces; year-round air conditioning with either one or two remote condensing units, suitable for installations with changing load conditions; a series of year-round air conditioners using one large condensing unit; and an outdoor furnace with provisions for a year-round air conditioning system at a future date. Heating units can use natural, mixed or propane gas and heat exchangers can be placed up or down-stream of the cooling coil.
Chrysler Corporation, Airtemp Div, P. O. Box 1037, Dayton 1, Ohio.

REMOTE AIR CONDITIONER

Rated at 93,000 Btu/hr, a new maximum power, 7½-hp, remote air conditioning unit has been added to the Polar-Prince line. Condenser air delivery is modulated by a low ambient capacity controller to maintain capacities required to cool commercial buildings. Standard equipment includes a large capacity receiver, moisture indicator and drier.



Coleman Company, Inc., Wichita 1, Kans.

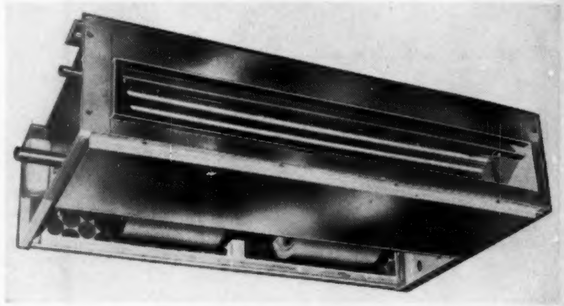
HOT WATER HEATERS

Four new gas-operated, automatic hot water heaters offered by this manufacturer are vertical models with all controls mounted in place, ready for fast installation. Model 200 has an input of 320,000 Btu/hr, provides recovery of 268 gph at a temperature rise of 100 F and has a storage capacity of 76 gal; Model 400 has an input of 535,000 Btu/hr, recovery of 449 gph and storage capacity of 135 gal; Model 600 offers 780,000-Btu/hr input, recovery of 655 gph and storage capacity of 170 gal; and Model 800 has an input of 945,000 Btu/hr, 793-gph recovery and 217-gal storage capacity.

Heaters operate on natural, mixed or LP gas. Each unit is equipped with two heavy-duty magnesium rods and all controls are self-generating.
Ewing Manufacturing Company, 2545 N.W. 10th St., P. O. Box 875, Oklahoma City, Okla.

AIR CONDITIONING LINES

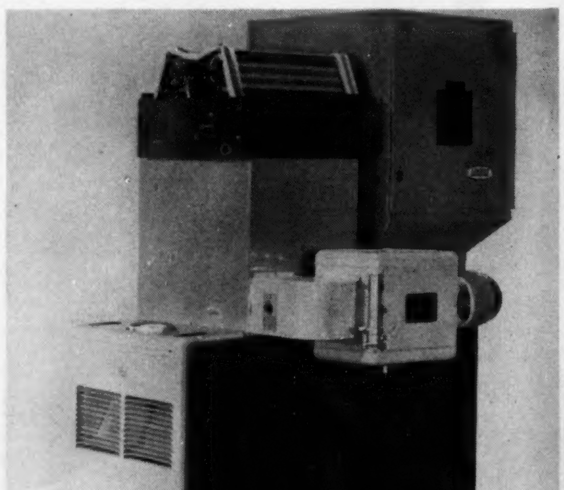
Two new lines of compact room-by-room air conditioners have been introduced for peripheral cooling and heating using floor-mounted units and hideaway applications over closets or furred-down areas. These models, Spotaire CRC (ceiling room conditioners; see illustration) and WRC (wall room conditioners) have been designed for a minimum depth overall of 8½ in. Initial capacities introduced in both lines are 200, 300, 400, and 600 cfm, with 800 and 1200-cfm units to be added.



Blower motor assembly, through use of wing bolts, is removable on the job. CRC plenum units are interchangeable, for either back or bottom return. Also offered is an auxiliary drain pan to facilitate mounting of controls on unit without insulation. Pivoted channels afford removal of filter without having to remove front panels.
Drayer-Hanson Div, Hi-Press Air Conditioning of America, Inc., P. O. Box 2215, Terminal Annex, Los Angeles 54, Calif.

FURNACE ASSEMBLY

Electrostatic air filtering, a gas furnace for controlling winter temperatures, spray humidifier and a cooling coil for summer air conditioning and humidity reduction are combined in a single assembly as shown.



Basically, the unit is a GF6-100 gas-fired furnace with foil-surfaced glass fiber insulation throughout. Mounted

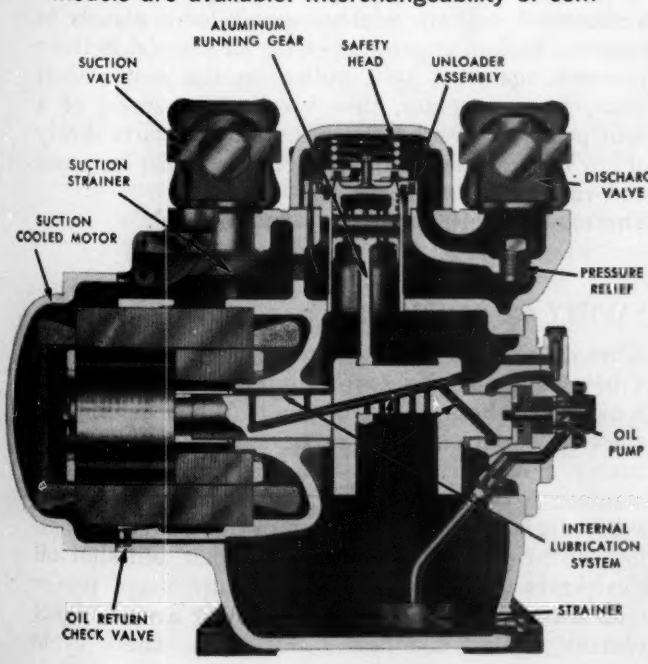
HERMETICALLY SEALED • BELT DRIVEN • DIRECT DRIVE • 10 —100 H. P.

For refrigeration and air conditioning, you can select the unit you want and need . . . you're not compelled to compromise on what's available . . . when you specify a BRUNNER Multi-Drive compressor or condensing unit.

Ranging from 10 H.P. through 100 H.P. these units offer a selection which permits unlimited flexibility in specifying.

Direct drive, hermetically sealed and belt driven models are available. Interchangeability of components keeps replacement part needs at a minimum. Aluminum pistons and connecting rods, integral lubrication system, built-in capacity control and oil failure switch are just a few of the superior design features which are standard on these units.

And behind every Brunner product is the peace of mind reassurance represented by over 50 years experience in the design and manufacture of quality compressors.



Hermetic compressors of the Multi-Drive line range in capacity from 10 H.P. to 100 H.P. and use R-22 refrigerant. Temperature ranges are from 10° to 50°F. Features include a motor stator that can be conveniently removed without the use of special tools, a safety device specifically designed to automatically trip all three phases of current as a protection against motor burnout, and suction cooled motor windings which maintain lower temperatures and assure longer motor life.

DUNHAM-BUSH

DUNHAM-BUSH, INC.

WEST HARTFORD 10, CONNECTICUT, U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES

on the return air opening is an electrostatic air cleaning device, cited as removing airborne particles down to 1/100,000 in. The spray humidifier can deliver up to 18 gal of water vapor in 24 hr.
Lennox Industries, Inc., Marshalltown, Iowa.

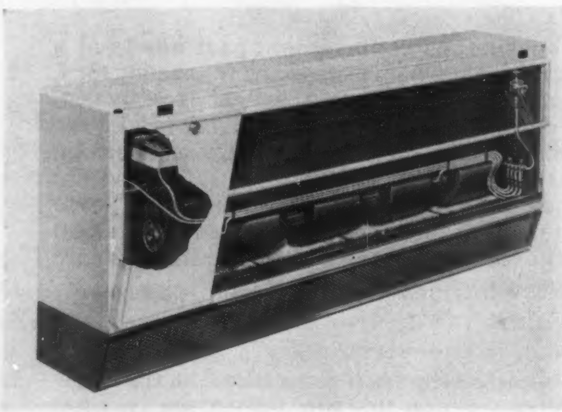
RESIDENTIAL HUMIDIFIER

For wintertime humidity control in forced-air installations, Model HR-2A has a 0.2-gph atomizing capacity and is designed for simple installation in the return duct of any heating or cooling system. Operation is on 115-volt, 60-cycle, single-phase power. The humidifier can be connected into an existing or new furnace installation and operates only when the furnace blower operates.
Westinghouse Electric Corporation, Air Conditioning Div, P. O. Box 510, Staunton, Va.

CABINET UNIT HEATERS

Designed for easy installation and maintenance, a new line of cabinet unit heaters is offered in 136 different models, 17 types in 8 sizes each. In addition to free-standing units, models are available for mounting on walls or ceilings and for recessed installation.

Shown in an interior view are a push-button lubrication system (top right) leading to the various oiling points; low-speed fans located at the bottom of the unit's main section, where they are isolated from the outlet grille; and piping, motor and controls



housed in an end compartment at the left. Units are available with either automatic or manual controls for use with hot water or steam systems. With optional equipment, the heaters can be used to ventilate with outside air. Air delivery capacities range from 250 to 2000 cfm.
Modine Manufacturing Company, 1500 DeKoven Ave., Racine, Wisc.

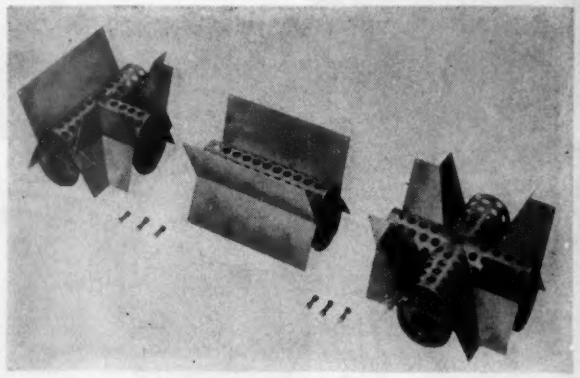
1961 ROOM AIR CONDITIONERS

Models in the Unitaire line are available to meet most design and installation requirements. All air conditioning functions—cooling, heating, dehumidifying, filtering and introduction of outside air—are controlled separately on each unit. Each room can maintain its own temperature and has a separate air supply.

Featured is a face and by-pass damper control that keeps temperature and air circulation constant, eliminating on and off operation and providing continuous air circulation along with modulated heating, cooling or dehumidifying. A specially designed angle fin coil permits straight-through air flow, cited as eliminating dead air spots in the coil.
Airtherm Manufacturing Company, Box 7039, St. Louis 77, Mo.

BURNERS

Used in conjunction with variable ratio-type mixers, Air-Stream burners can attain a turndown ratio of



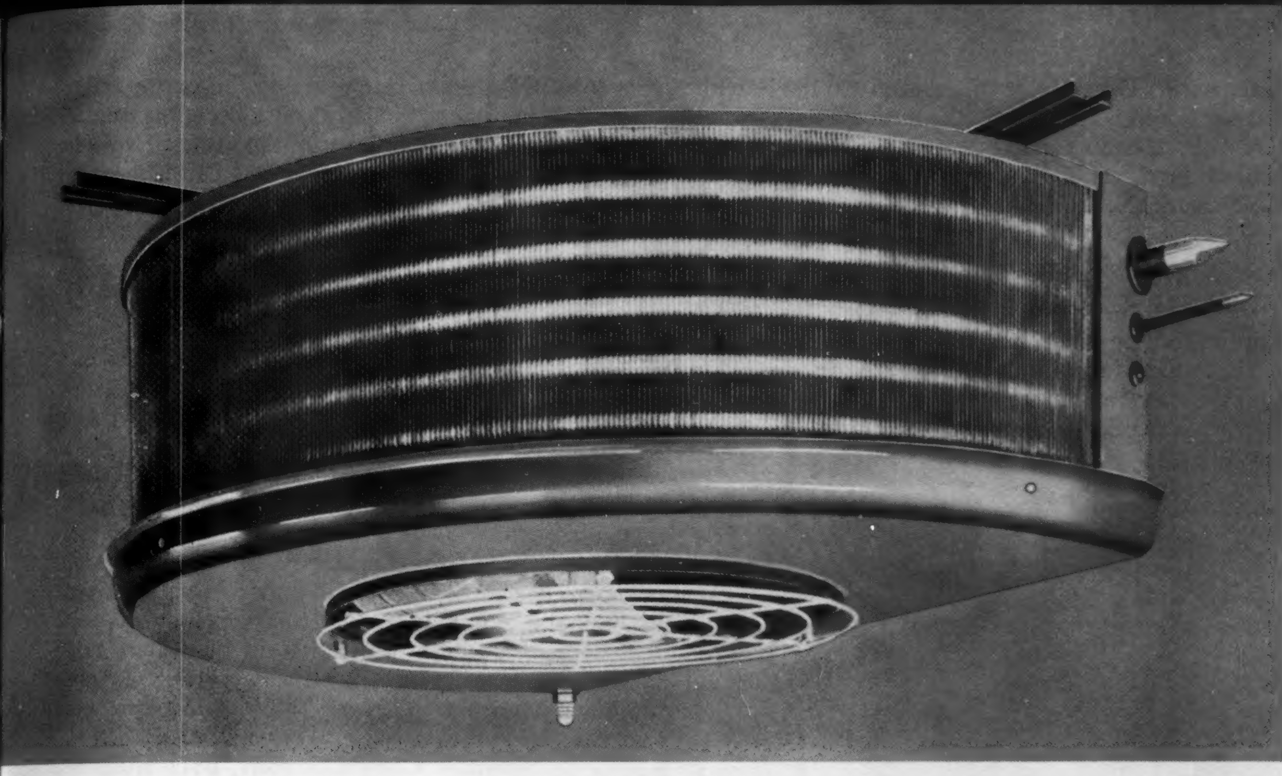
25:1 with air make-up heating systems. Recommended maximum air velocities are 3000 fpm in air make-up systems and 3500 fpm in oven heaters. Capacities are available to 400,000 Btu/hr per 12-in. burner section. Burners are offered in a variety of sections, including straight, T and crosses.
Eclipse Fuel Engineering Company, Combustion Div, Rockford, Ill.

BLOWER CONTROL

Operation of this variable-speed blower control is as follows: a flexible hose passes sample plenum air over a shrouded bellows which expands or contracts in response to the temperature of the air sample. Bellows pressure against a split pulley on the motor shaft changes its diameter, thus varying the speed of a split pulley on the blower. The blower starts slowly at low heat, reaches normal speed as the heat increases and reduces speed gradually.
Thermo-Products, Inc., North Judson, Ind.

SAFETY CUT-OFF

Electric baseboard heaters now are equipped with a new safety device to prevent overheating should a piece of fabric fall on the unit. When a handkerchief or other object is dropped on the heater, it causes a rise in temperature. This increased temperature is transmitted along a liquid-filled capillary tube which runs the full length of the heater, activating the Safe-T-Stat to break the circuit and shut off the power. After a 50 F temperature drop, power is switched on automatically. As long as the object remains against the heater this off-on safety cycle



Larkin Coils feature Wolverine Tube in HUMI-TEMP units

Electro-tinned seamless copper tubing manufactured by Wolverine Tube, is one of the important components used by Larkin Coils, Inc., in production of its Humi-Temp units for walk-in coolers, cold storage rooms and allied installations.

Larkin, one of the best known OEM names in the refrigeration and air conditioning industry, features Wolverine light wall special temper tube in fabrication of its exclusive Cross Fin Coils, as well as in suction and liquid lines.

In addition to meeting Larkin's high standards of quality, Wolverine tubing for this application is manufactured to ASTM B-75 specifications. Each foot is rigidly quality controlled throughout the entire manufacturing process—each tube is made the Wolverine Tubemanship way to give maximum performance under the toughest operating conditions.

If your company uses copper, copper alloy or aluminum tubing, why not specify Wolverine, as does Larkin and other leading American companies. For complete information about the products and services of Wolverine Tube, Division of Calumet & Hecla, Inc., write for a free copy of the Wolverine Tubemanship Booklet.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. O, 17244 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

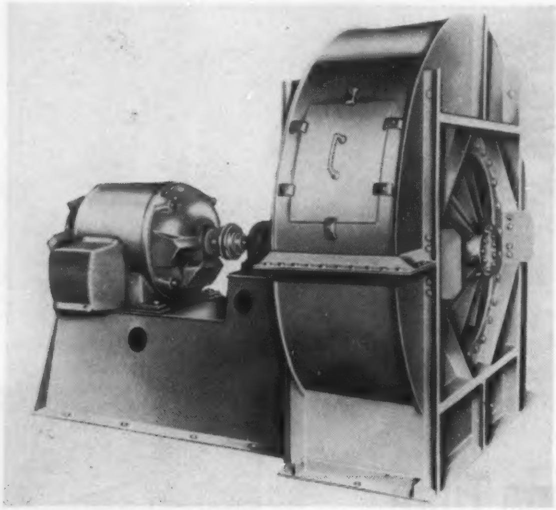
PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

9550

repeats itself. Control cut-off is fixed at 195 F with a thermal differential of 50 F. Operation is on current to 277 volt, 25-amp capacity.
Seaboard Products Corporation, 191 Frelinghuysen Ave., Newark, N. J.

INDUSTRIAL CENTRIFUGAL FAN

Featuring the use of airfoil blading, these new heavy-duty industrial fans (Series 8500) are designed for high efficiency at direct-connected motor speeds. Suitable applications include: combustion air, pack-



aged steam boilers and industrial processes such as glass cooling, vacuum drying and exhaust from aluminum pot lines. With capacities from 15,000 to 450,000 cfm, the units are available in five ac direct-connected motor speeds: 1800, 1500, 1200, 900 and 750 rpm. Within this range are included ten sizes of AMCA Class III-type fans with wheels from 30 to 81 in. diam and fourteen sizes of Class IV-type fans with wheel diam from 30 to 109 in. The fans can handle air from –20 to 800 F.

Bearings are integral with the fan unit and the motor (or turbine) is direct-connected to the fan shaft through couplings. Fans are of heavy steel construction, with all housings built for fixed discharge and split for rapid wheel removal and easy maintenance. Flanged inlets and outlets are standard on all sizes. **Westinghouse Electric Corporation, Sturtevant Div, 200 Readville St., Hyde Park, Boston 36, Mass.**

CEILING AIR DISTRIBUTION

Uniform air distribution is cited as being provided without air diffusers or ducts by the Airson System. Slots cut into foil-backed Acoustone ceiling tile permit air to enter a room from the plenum space above the ceiling. Each tile acts as an air-supply vent to distribute air evenly across the entire ceiling surface. Maintained under constant pressure, air flows through all slot openings at the same air velocity to keep ceiling-to-floor temperatures consistent. Air supply within different sectors of a room is controlled by adjustable slides on the back surface of each ceiling tile.
United States Gypsum Company, 300 W. Adams St., Chicago 6, Ill.

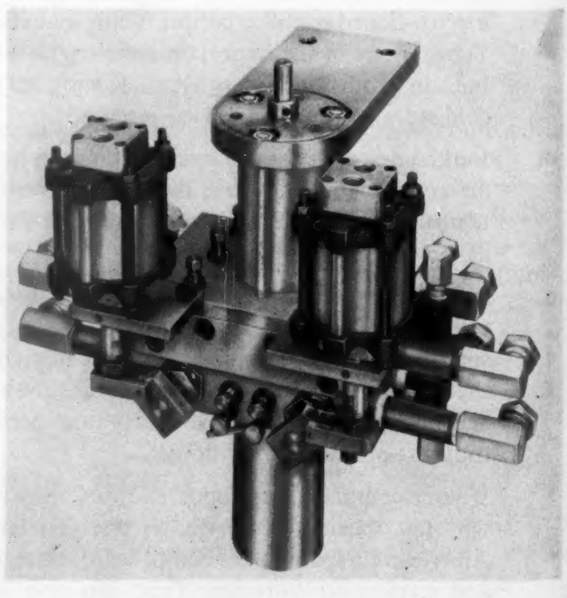
HOW CAN ODOR-CONTROL METHODS BE EVALUATED TO PROVIDE THE MOST ACCURATE RESULTS? PAGE 49

CHEMICAL FEEDER

To pump chemical treatment into cooling towers, evaporative condensers or other unpressurized water systems to control and prevent development of algae and other bacteriological formations, thus maintaining a clean, free-flowing water system, the Glaspump chemical feeder is now available. Primary feature of the unit is a low friction, unbreakable stopcock that does not require lubrication and does not move under vibration. Flow control valve permits ¾ gpm at line pressures to 125 psi. Check valve prevents backflow into chemicals.
California Scientific Glass Company, 9811 Rush St., El Monte, Calif.

FOAM MIXING HEAD

Up to six separate foam material streams can be valved into the mixing chamber for on-off operation in this new development, nominally rated at 100 lb/min. Multiple-component design is cited as eliminating the time factor encountered when pre-mixing of ingredients results in material loss through chemical deterioration. Features of the mixing head are



fast-acting valving, interchangeable metering port design and self-cleaning, straight-side mixing impeller. Many formulations can be mixed at rates in excess of 150 lb/min for molding, pouring-in-place or slab production of rigid and flexible polyurethane foams.
Martin Sweets Company, Inc., 114 S. First St., Louisville 2, Ky.

News highlights of the month

TRENDS

All-Industry Committee

Frozen Foods All-Industry Coordinating Committee has announced a joint five-year program whose objective is to further advance handling standards in the frozen food industry. Major phases include immediate promulgation of voluntary operating practices throughout the industry, progressively tightened in the next five years; indoctrination of employees at all levels to understand the importance and proper techniques of maintaining product quality; and encouragement of the development and use of better and more efficient equipment. Dr. H. C. Diehl (ASHRAE Fellow) is Chairman of FFAICC, P. O. Box 1275, Colorado Springs, Colo.

Air conditioned stores

As reported by the Air-Conditioning and Refrigeration Institute, the nation's chain stores will spend $173 million for air conditioning in 1961, much of it in modernization of existing stores. Air conditioning is the largest single item in a projected expenditure of $1.95 billion by the chains for construction and modernization this year, it was pointed out.

Thermoelectric suit

Developed for the Navy by Westinghouse, a self-contained, air conditioned suit is stated as giving comfort in temperatures as low as –40 F and as high as 135 F. Heated or cooled by thermoelectricity, two small fans circulate conditioned air around the wearer and to his face mask for breathing. Reported in Mechanical Engineering, Vol. 83, No. 6, June 1961.

Thermoelectric refrigerator

Welbilt Corp. has demonstrated a prototype of a thermoelectric refrigerator which it is planning to produce in quantity in 1962 at prices competitive with compressor type cooling equipment. The 1½-cu ft, portable unit has a freezer compartment holding two ice cube trays.

BOOK REVIEWS

Instrumentation and controls

Authoritative and quantitative data designed to aid in the selection and application of instruments and control systems for mechanical services in commercial, institutional and industrial buildings are provided in "Handbook of Instrumentation and Controls" by Howard P. Kallen. From a review of fundamentals, the book proceeds to detailed discussions of complete control systems for boiler and power plants, heating plants, mechanical drives, air conditioning, ventilation and refrigeration. Including numerous illustrations, tables, charts and graphs, the book contains information helpful in procuring, specifying or designing equipment. McGraw-Hill Book Company, Inc., New York, N. Y., price, $15.

Dairy engineering

Now available, "Proceedings of the Ninth Annual National Dairy Engineering Conference" includes papers presented at that meeting which took place at Michigan State University, February 28 and March 1. Copies may be obtained from the Continuing Education Service, Michigan State University, East Lansing, Mich., price, $2. Subject of this meeting was automation; next Conference, to be held February 27 and 28, 1962, will cover automation components.

Russian bibliography

Cited as the only bibliography on Russian literature in the field, "Refrigeration Engineering—A Source Book of Soviet Literature" covers all aspects of the subject for the period 1923-55. Translated through the National Science Foundation from the bibliography given to those attending the meetings of the International Institute of Refrigeration in Moscow in 1958, this volume is available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C. for $3.

Solar radiation

Covered within "Solar Radiation in Air Conditioning" by Ivor S. Groundwater are the sources of solar design data and building absorption coefficients; ways of reducing the flow of solar heat into roofs; and tabulations of different methods to show their advantages and disadvantages from several points of view. Published in London, England, the book is distributed in this country by John de Graff, Inc., 31 East 10th Street, New York 3, N. Y., price, $6.

Effects of hot climates

Reporting upon a seven-year program of research, "Physiological Responses to Hot Environments" contains information on relative contributions of air temperature, humidity and air speed to the severity of hot environments; effects of working at various rates of energy expenditure; effects of wearing different amounts of clothing; and effects of radiant heat of long wavelength. This research program, conducted in London and Singapore, also provided information on the validity of a widely used scale of environmental heat stress and a new index developed in the course of the program. Medical Research Council Special Report Series No. 298. Published by Her Majesty's Stationery Office, London, England.

Estimating guide

Intended as a standard for practical estimating, "Mechanical Estimator's Guide", Second Edition, by John Gladstone contains labor and material cost data for air conditioning of many descriptions. Enlarged from an earlier edition, this volume includes new estimating forms, diagrams and illustrations. Technical Guide Publications, Inc., 224 N.E. 59th Street, Miami 37, Fla., $6.95.

Consulting engineers

Exploring the consulting engineer's professional relationships to his client, to other companies and to the public, "The Consulting Engineer" by C. Maxwell Stanley also covers the internal problems of a consulting practice and discusses the many areas of organization, personnel, plant facilities, procedures and management with which the consulting engineer deals. John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y.; price, $5.95.

Cold storage

U.S. Department of Agriculture's Cold Storage Report reveals that refrigerated warehouse holdings of frozen foods on May 1 were 2.8 billion lb, cited as a record for this date. 70 per cent of this total was held in public refrigerated warehouses, yet public freezer space was only 64 per cent occupied, on the average. According to the National Association of Refrigerated Warehouses, the more than 350 million cu ft of public freezer space in the U.S. is capable of storing a total of 4 billion lb at one time when utilized at maximum efficiency. The 1961 Directory of Public Refrigerated Warehouses may be obtained, without charge, from NARW, Tower Building, Washington 5, D.C.

SPECIAL MEETINGS

Heat transfer

Approximately 125 papers on the general theme of "New Developments in Theory and Practice" will be available for discussion at the Second International Heat Transfer Conference, to be held in Boulder, Colo., August 28-September 1. Nine sessions have been scheduled where the papers will be summarized in topical groups by reporters, followed by written and oral discussions from the floor. Papers will derive from the U.S., United Kingdom, Canada, Japan, U.S.S.R., France, Switzerland, Australia, Italy, Germany, Sweden and other countries. Sponsored by the American Society of Mechanical Engineers and the American Institute of Chemical Engineers; ASHRAE is among numerous participating societies.

ASME meets

1961 Summer-Annual Meeting of the American Society of Mechanical Engineers was held in Los Angeles, Calif., June 11-14. The program consisted of numerous technical sessions, a business meeting and various social functions, supplemented by tours to surrounding points of interest.

Electric heating

Electric Comfort Heating Equipment Section of the National Electrical Manufacturers Association has adopted the theme, "Sell Electric Comfort Heating Cooperatively" for its second National Electric Comfort Heating Exposition and Symposium, to be held March 19-21, 1962 in Chicago, Ill. Program will include six seminars where discussions will feature calculations for electric heating, methods and selection of proper equipment and selling electric heat, with special emphasis upon new advances.

INDUSTRY CHANGES

New ARI Section

To be known as the Non-Residential Warm Air Heater Section, a new Product-Section has been organized within the Air-Conditioning and Refrigeration Institute. Recommended scope will cover "Warm air heaters, of 200,000 Btu/hr output and above, which are factory assembled and fire-tested, suitable for use with oil, gas or a combination of fuels, consisting of a burner unit, heat exchangers, blower section, casing and controls. These heaters are suitable for use with ducts, discharge nozzles, grilles or louvers and filters." Similar non fire-tested equipment is provided for.

Photo Actual Size

where high starting torque is essential

RANCO H80 VOLTAGE STARTING RELAYS on capacitor-start motors up to 5 hp., provide high starting torque for low temperature systems, commercial refrigeration, air conditioning units, and heat pump systems. Relay contacts open and close by variation of the magnitude of the voltage applied to the relay coil. At the instant of starting the motor, the normally closed relay contacts stay closed until the motor builds up speed and the start-winding voltage increases. Special air-gap construction eliminates the problem of "residual magnetism" between armature and core after the relay is de-energized. Relay coil and contacts withstand switching of high transient voltages. High contact pressure prevents relay contact from bouncing and sticking. And the rugged construction of the Ranco H80 provides remarkable resistance to shock and rough handling. Write for further information and Technical Bulletin 1806.

RANCO CONTROLS

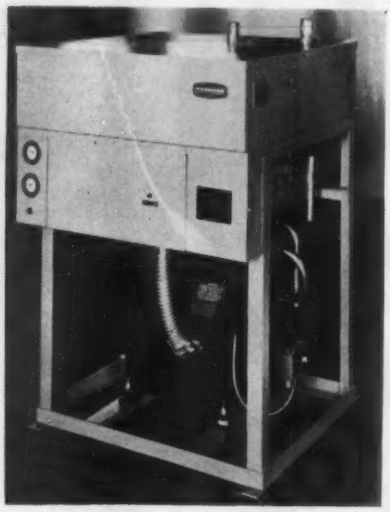
Ranco®
INCORPORATED
COLUMBUS 1, OHIO

In Canada: Ranco Controls, Canada, Ltd., Toronto 18, Ontario

PARTS AND PRODUCTS

WATER CHILLERS

First of a series of chillers being developed for compact installation are two units, with capacities of 17 and 25 ton, for multi-room and industrial process applications. Factory assembled, piped, wired and tested, the units are shipped with a holding charge of Refrigerant 22. Featured are tube-in-tube evaporator and condenser coils made from admiralty brass for protection against corrosive water conditions. An alternate model



for air-cooled installations is supplied without the water-cooled condenser and may be hooked directly to an external air-cooled condenser.

Available with either capillary refrigerant feeding systems or thermal expansion valves, the chillers operate on either 220 or 440-volt service. Each is equipped with motor starting and protective devices, circuit breakers, high and low pressure protection on refrigerant lines, chilled liquid low temperature cut-out and liquid temperature control.
Hupp Corporation, Typhoon Heat Pump Div, P. O. Box 1123, Tampa, Florida.

REDESIGNED PUMPS

Designed for booster service up to 60 psig in suction, boiler feed, condensate return, transfer or circulation, redesigned Model ISA has an extensive choice of mechanical seals. Offered are 85 sizes with the following maximum limits: discharge 160 psig, suction 60 psig, mechanical seal 110 psig and temperature 210 F. Featured are: renewable liners, rigid impeller mounting squared against shaft shoulder, separable liquid end isolated from bearing frame, adjusting collar for positive impeller location and a preloading spring to hold diagonal loading on both ball bearings.
Roy E. Roth Company, Turbine Pump Div, Rock Island, Ill.

PLASTICS COATINGS

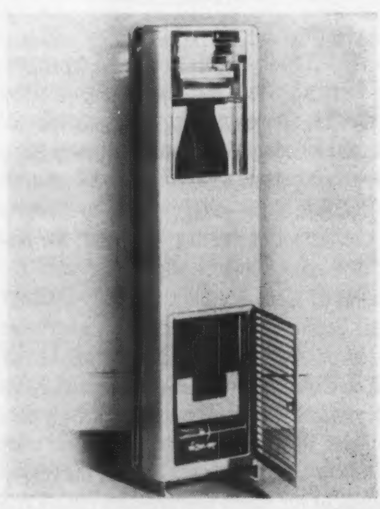
Heat Bar Liquid Plastic No. 10 and 20 are easily-applied, permanent, heat-reflecting coatings for windows and skylights, cited as reducing interior temperatures by reflecting up to 80% of the radiant heat striking them. Both coatings also absorb ultra-violet.
Professional Progress Research Company, New Buffalo, Mich.

SOUND ABSORBER

Constructed of heavy gauge galvanized sheet steel, the Tubular utilizes an absorber-within-an-absorber design to provide a greater area of exposed glass fiber without appreciably affecting the in-system air velocity. Nose cones, front and rear on the free-air body, provides a 360-deg distribution of air entering the absorber and create minimum resistance to air flow.
American Engineering Company, High Point Industrial Park, Sedalia, Mo.

WALL HEATERS

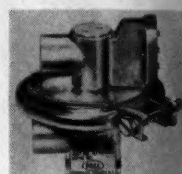
Range of the 18 models in this line is from 25,000 to 50,000 Btu/hr. Single



wall units are available in 25,000 and 35,000 Btu/hr, dual wall heaters in 35,000 and 50,000 Btu/hr and rear register models in 25,000 and 35,000 Btu/hr. A new heat exchanger design is cited as reducing expansion and contraction noises, by placement of the binding of metal on metal far up in the casing where the heat exchanger meets the flue. At this point a glass coating is provided.
Pioneer Manufacturing Company, 3131 San Fernando Rd., Los Angeles 65, Calif.

LIGHT-WEIGHT SWITCHES

System pressures or overpressures to 250 psi are cited as producing no damage or leakage in this new line of light-weight switches for industrial and airborne systems. Newly designed Deltadyne pressure and differential pressure switches cover an actuation range from 0.125 to 16 psi differential. Operation is by means of a magnet mounted in a spring-biased elastomeric diaphragm on which the differential pressure acts. Motion of the diaphragm is magnetically transmitted to the actuating mechanism through a metallic wall, minimizing sealing problems and insuring isolation of the electrical mechanism from the fluid.



Standard models are supplied with aluminum housings; stainless steel, brass and other metals are available on special order. These adjustable switches can be used in most types of fluid lines, including pneumatic systems and compressed gas lines.
Pall Corporation, 30 Sea Cliff Ave., Glen Cove, N. Y.

UNIT COOLER

Compactness is featured in a newly designed unit cooler, the Vee-Aire. Available in two sizes, 650 and 800 Btu/hr at 10 F TD, the coolers are but 6¾ in. high and can be mounted from the ceiling, back wall or end walls. Air is drawn in over the coil surface and discharged downward and to each side. Thermal expansion valve mounts inside the unit and a drain pan is furnished as standard equipment.
Bohn Aluminum & Brass Corporation, Danville Div, Danville, Ill.

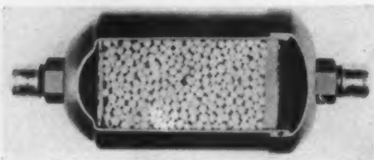
BLOCK VALVES

For mounting in various types of industrial high vacuum systems, these block valves have a common bellows seal assembly for sizes less than one

in., are factory leak tested and compact in design. Machined from solid brass square stock, the porosity-free valves are available with in-line or angle configurations for soldered or screwed connections in sizes from ¼ to 1½ in. Standard O-rings and disc gaskets are neoprene, but other materials are available on request.
NRC Equipment Corporation, Subsidiary of National Research Corporation, 160 Charlemont St., Newton 61, Mass.

REFRIGERATION DRIER

With high filtering and drying capacities, and built to withstand rough handling, the System Boss is an in-line refrigeration drier with filter capacity dependent on refrigerant

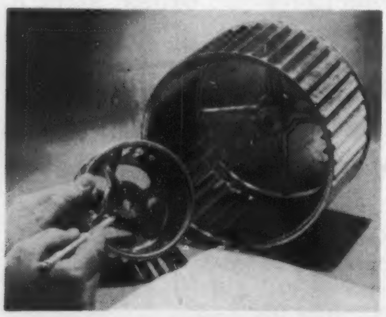


flow rate. There is no by-passing in the unit, because the drier's glass fiber inlet pad, when full, will allow additional solids to go on to a glass fiber unitized outlet filter.

Used as a desiccant is Andrite, pelletized activated alumina, cited as offering less resistance to flow than bloc-type desiccants. Engineered for a high flow rate resulting from a low pressure drop, a 16-cu in. drier, for example, with a ⅝-in. fitting, at air conditioning rates of flow and 2-psi pressure drop, can handle 10.3 ton flow of Refrigerant 12 and 13.8 ton flow of Refrigerant 22.
Ansul Chemical Company, Marinette, Wisconsin.

SMALL BLOWER WHEELS

For air moving in oil burners, fan coil units, window air conditioners, space heaters, wall furnaces, kitchen



ventilators and automobile heating and air conditioning systems, a new line of small blower wheels is offered in four diam and twelve blade lengths. Blade lengths range from 2 to 4-3/4 in. in 1/4-in. increments and diam are 4-3/4, 6, 7-7/16 and 8-1/2 in.

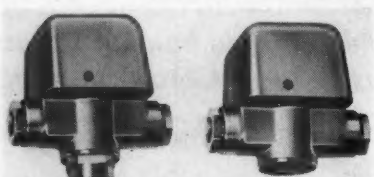
Strong and rigid, the new wheels are made of aluminum, cold rolled steel or zinc grip. Backs are solid, pied out or coned. Both single and double inlet types are available.
Lau Blower Company, 2027 Home Ave., Dayton 7, Ohio.

UPRIGHT FREEZERS

Two new Chill-Air upright freezers with electric automatic defrost systems are now available from this manufacturer. Primary application of both units, which are fully self-contained, is for storage of frozen foods. Model UF 30 has a capacity of 30 cu ft and a 1/3-hp air-cooled condensing unit; Model UF 50 has a 50-cu ft capacity and a ¾-hp air-cooled condensing unit. Each features wide range controls to allow for operation at desired temperatures and has low temperature blower coils to permit rapid recovery following automatic defrosting cycles.
Erickson Industries, Inc., River Falls, Wisconsin.

MOTOR VALVES

Both two and three-way motor valves (at right and left, respectively, in the illustration), designed to control flow of hot or chilled water in fan coil units and other applications, now are offered as the 436A Series. Design of the valve disc has eliminated use of



screens. Valve construction is of forged brass and units are compact in size to facilitate mounting in coil housings.
Erie Manufacturing Company, 4000 S. 13th St., Milwaukee 21, Wisc.

ELECTRICAL THERMOMETER

Model T-1 is a production, laboratory, maintenance or field instrument that will determine temperature of surfaces, liquids or gases upon application of a thermistor sensing probe to the surface of the substance to be tested. Revision of the thermometer has been made to allow instant direct reading of temperature in combination Fahrenheit-Centigrade scale readings. Portable and compact, the unit is cited as being accurate to ½ to ¾% of the total instrument range.
Ameresco, Inc., 7 Center Ave., Little Falls, N. J.

MOTOR STARTER

Featuring a 25% reduction in size, a reduced voltage autotransformer starter for use in air conditioning is a size 6 controller and is but 90 in. high, 36 in. wide and 28 in. deep. Dimensional reductions were made possible by small contactors, rated 600 volt, 600 amp for either front or rear connection. Contactors are mounted on a steel panel 19¼ in. wide, 13¾ in. high and 8 in. deep.
Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

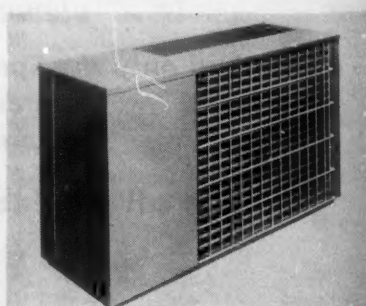
ACOUSTICAL BOARD

Constructed of specially formulated mineral fibers, this perforated mineral acoustical ceiling board has a two-hr

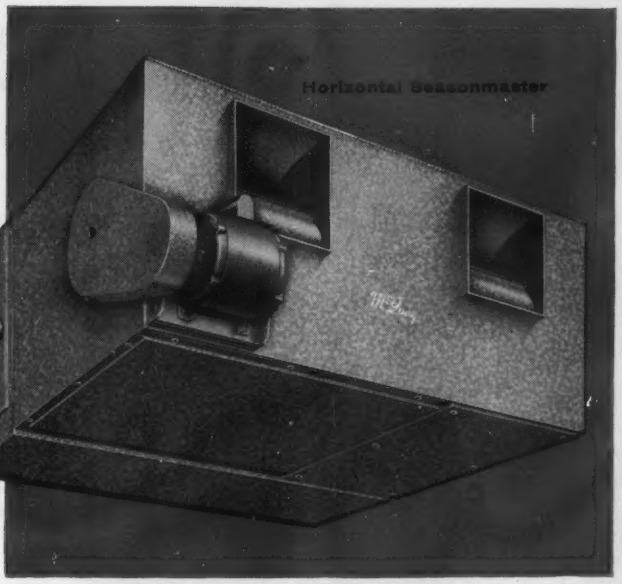
fire rating and is placed on exposed steel grid systems of two by two-ft or two by four-ft sizes. High sound absorption is featured. Boards are removable for easy access to the plenum.
Elof Hansson, Inc., Acoustical Div, 711 Third Ave., New York 17, N. Y.

REMOTE CONDITIONERS

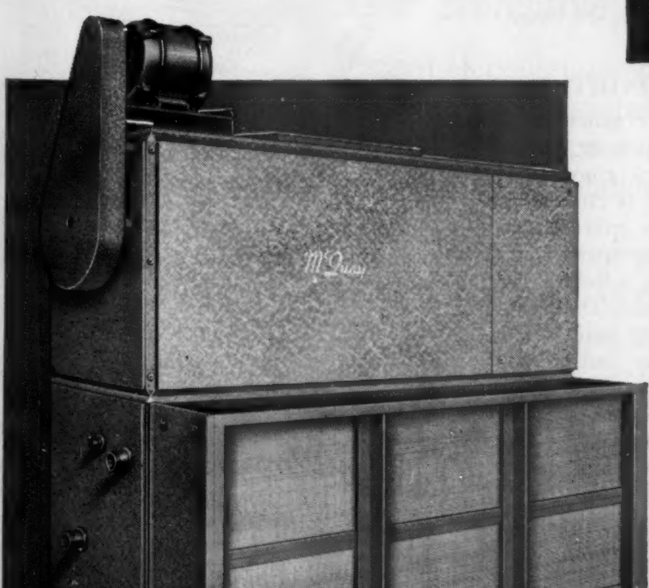
Hideaway dimensions characterize the DNR series of air-cooled remote compressors for residential and light commercial air conditioning. First of the series to be introduced is Model 30, rated at 30,000 Btu/hr at 95 F. It is



to be followed by the five-ton, 60,000-Btu/hr Model 60. Model 30 is 16-7/8 in. wide, 25-13/32 in. high and


Horizontal Seasonmaster


Multi-Zone Seasonmaster

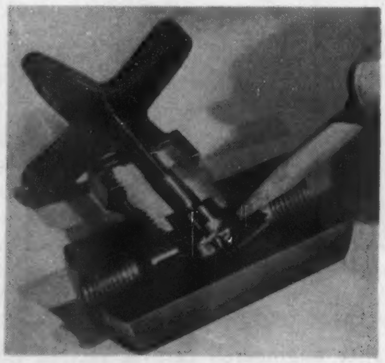

Vertical Seasonmaster

44½ in. long. Narrow width has been achieved by a side-intake, top-discharge pattern of handling condenser air. Condenser coil has 5.53 sq ft and three-row design with 1/2-in. tubes and 13 ripple-surface aluminum fins per in. The fan is a 16-in. propeller type, powered by a 1/6-hp, 1050-rpm motor. Controls include compressor contactor, transformer and high and low pressure controls.
Day & Night Manufacturing Company, P. O. Box 2222, La Puente, California.

SHUT-OFF VALVE

Available in four sizes, ¼ through ¾ in., a new high pressure shut-off valve is equipped with a Teflon seat compressed into a positive sealing O-ring. Housed in a stainless steel swivel cage attached to a free turning Monel steel stem, a portion of the Teflon seat is forced from the cage as the valve stem is screwed down to the closed position, forming a Teflon-to-metal seal.

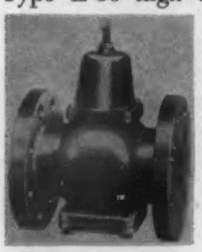
Suitable for a wide range of industrial installations, the valve has a body of 18-8 stainless steel. When the valve is closed, the stem packing can be replaced without removing it



from the line. Rated at 10,000 NSCWP, the valve is opened and closed easily under extreme pressure.
Clayton Mark & Company, 1900 Dempster St., Evanston, Ill.

PRESSURE REGULATORS

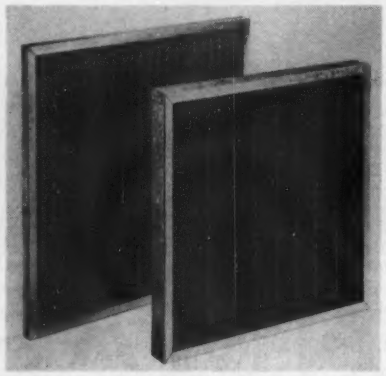
Available in 2, 2½ and 3-in. sizes, Type E-56 high capacity regulators are offered with screwed, 150-psi flanged and 300-psi flanged ends, suiting them for large commercial and industrial water systems. Of the balanced piston type, units are all bronze with bronze trim. They may be used for inlet pressures to 400 psi and reduced pressures in two ranges, 10 to 60 or 50 to 125 psi. Maximum recommended temperature is 150 F.



A. W. Cash Valve Manufacturing Corporation, P. O. Box 191, Decatur, Ill.

DRY-TYPE FILTERS

Interchangeable with standard sizes of throw-away filters for original



equipment, Kleen Kwik dry-type, permanent air filters can be installed on present equipment without modification. No spraying equipment, adhesives or oils are required and filters can be cleaned by washing with warm water. Made of finely divided plastics materials, the filtering media traps minute dust particles as well as larger dirt particles in the air. Lint screens are provided on each side of the filter. The filtering medium is encased in galvanized steel with two steel faces to protect the material.
Air Filter Corporation, 4548-K W. Woolworth, Milwaukee 18, Wisc.

ADAPTABLE CONDITIONER

Extensive application potential of the Adaptomatic V, a unitary central air conditioner which is convertible for remote installations, is cited as being made possible by a split chassis design, with the compressor-condenser section separated by a bulkhead from the evaporator section. Thus, the unit may be installed in one piece, or equipped with four cut-off service valves, as a remote system. Available in four models, two with heat pumps and optional supplementary resistance heating, the five-hp Adaptomatic has a capacity of 60,000 Btu/hr.
Fedders Corporation, 58-01 Grand Ave., Maspeth 78, N. Y.

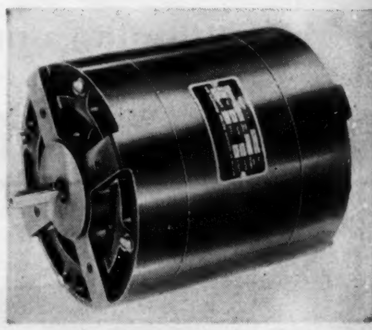
RESIDENTIAL UNITS

Introduced recently were the following additions to this manufacturer's line of residential heating and air conditioning equipment: 7½-ton condensing unit and companion evaporator blower section; 7½-ton horizontal evaporator coil; blower coils from two through five ton; cast iron gas furnace; 210,000-Btu/hr unit added to the OBN oil boiler series; redesigned upshot gas conversion burner; redesigned horizontal oil furnace; and a 335,000-Btu/hr unit added to the horizontal oil furnace series.

Changes made in the horizontal oil furnace include a more compact, corrugated heat exchanger; lower stack temperatures; elimination of baffles from the radiator; and use of a burner-mounted primary control. Design of the blower coil series is such that the blower assembly can be used either for vertical or horizontal air flow.
Silent Automatic Products, 3170 W. 106th St., Cleveland 11, Ohio.

FRACTIONAL HP MOTORS

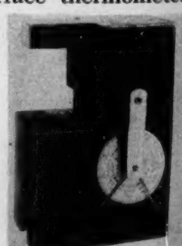
Designed for compact packaging, fourteen fractional hp, frame size 11 (4⅝ in. diam) ac motors are available in these types: low slip induction, torque, and single, dual and three-speed hysteresis motors. Operation is on 60 or 400 cycle; single, two or three-phase; 115 or 120/208 volt. Developed hp ranges from 1/150 at 900 rpm to 1/3 at 3300 rpm, depending



on the application. Motor housings are aluminum, cast around the laminations.
Ashland Electric Products, Inc., 32-02 Queens Blvd., Long Island City 1, New York.

SURFACE THERMOMETER

Easy to read, compact and fast operating, this spot surface thermometer has a range from 0 to 540 C and is made entirely of stainless steel. For use on any surface, the instrument also can measure ambient temperatures in furnaces, ovens and other enclosed spaces. In addition to the basic thermometer, there is also available



a magnetic clip making possible use of the unit on non-horizontal ferrous surfaces. A set of auxiliary pointers record the minimum and maximum temperatures attained during a measuring period.

Ranges available are: 50 to 1000 F, 50 to 500 F, 0 to 320 F and 0 to 270 F. All units are calibrated to within ±2%.

Pacific Transducer Corporation, 11836 W. Pico Blvd., Los Angeles 64, Calif.

SOUND METER

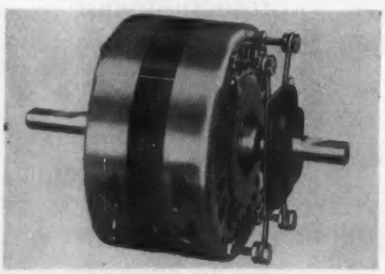
Measuring 2 x 3 x 6 in., the new Model 450 weighs two lb and is operated on a 22.5-volt battery with

an operating life of 30 hr. Range of operation is from 35 to 142 db sound level and 40 to 8000 cps response. A direct reading scale minimizes chance of reading errors. Completely transistorized, the meter comes in a heavy gauge aluminum case. Among cited uses is checking conformity to specifications in air conditioning and ventilating installations.

H. H. Scott, Inc., Instruments Div, 111 Powdermill Rd., Maynard, Mass.

REPLACEMENT MOTOR

Developed to meet the problem of replacing motors in older style air conditioners using square-type mountings, the Type AR fractional hp elec-



tric motor is available in single and two-speed models, 115 and 230 volt, 1050 rpm. A six-pole, shaded pole type, it has a range from 1/10 to 1/6 hp.

Replacement of a motor is simple, as the Type AR fits into the base of the unit. Adjustments are easy to make, since the nut is placed at the desired spot on the through bolts and tightened.

Redmond Company, Inc., Owosso, Michigan.

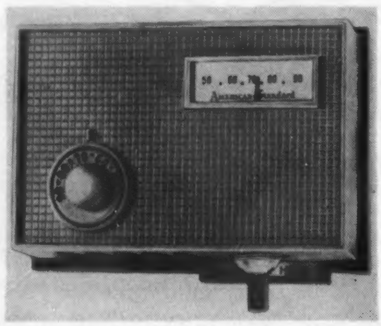
EXPANSION JOINT

Inner construction of the AMR (anti-migration rubber) Expansion Joint enables the metal re-enforcing rings to remain stable under pressure. For use in systems that require piping capable of withstanding flow surges and high pressure, the joint can handle corrosive materials and withstand a wide range of temperatures. It is available in a variety of constructions to meet most industrial applications.

United States Rubber Company, 1230 Ave. of the Americas, New York 20, New York.

THERMOSTATS

To provide temperature control of residential, commercial and industrial heating, cooling or year-round systems, an improved line of CB-440 Series Thermostats is offered. Combining compact design and high sen-



sitivity, the controls operate on either line or low voltage, can be mounted without adapter plate on a standard 2 x 3-in. switch-box and are not affected by vibration. Units are available in six standard models with built-in sub-base features to meet an extensive range of applications.

American-Standard, Controls Div, 5900 Trumbull Ave., Detroit 8, Mich.

SAFETY REFRIGERATOR

Added to this line of explosion-proof refrigerators, a ten-cu ft unit is designed specifically for use in research laboratories, wherever flammable or explosive chemicals are stored or where conditions of the surrounding air are such that explosion-proofing is mandatory. Safety refrigerators in this line will operate in high ambient temperatures and have no sources of ignition on either the interior or the exterior of the box. All arcing devices are located within an explosion-proof motor compressor housing. The new unit is identical in appearance to a kitchen-type refrigerator and will plug into any standard wall socket.

Kelmore, Inc., 599 Springfield Ave., Newark 3, N. J.

POWER VENTILATORS

Belt-driven units for installation where hot, moist, corrosive or fume-laden air is exhausted have been added to this line of power roof ventilators. Fans on these units are belt-driven by a motor mounted on a weatherproof housing outside the gas stream. Rigid motor supports are welded to the outside of the ventilator casing.

Features include all-welded construction; sealed, pre-lubricated, self-aligning fan bearings; nylon damper hinge bearings; weatherproof motor housings; hinged discharge for easy access; and leakproof, lightproof dampers. Ventilators are available in twenty sizes and free air capacities from 2000 to 60,500 cfm. Capacities at ½-in. static pressure range from 1350 to 53,000 cfm.

L. J. Wing Manufacturing Company, 2300 N. Stiles St., Linden, N. J.

GAS BURNERS

Star-Sixties Spiral-Flame Burners create a flat, spiral flame which hugs the arch and walls of heat-treat furnaces, galvanizing tanks and similar equipment. Radiation effect, caused by the flame touching large areas of the furnace wall, increases over-all heat transfer rates. Six sizes of burner provide capacities from 100,000 to

1,800,000 Btu/hr. Flame diam ranges from 13 to 60 in. Burners are factory assembled and tested.

Eclipse Fuel Engineering Company, Rockford, Ill.

SOLUBILITY OF REFRIGERANTS IN ORGANIC SOLVENTS LINKS TO THE DEVELOPMENT OF AN ECONOMICAL ABSORPTION COOLING CYCLE PAGE 71

ASHRAE JOURNAL
JULY 1961

Comment

WISHING WON'T MAKE IT SO

"The trouble with most folks", observed earthy Josh Billings for his 19th Century audiences, "is they know so many things that ain't so." We doubt, even in this time of greatly accelerated education and of informational dispersion that the situation has altered much toward improvement.

In the absence of facts, some folks still go charging off on the basis of self-pleasing assumptions; call it wishful thinking. You can see it all around you; perhaps others may observe it in you, too.

The hotter the controversy, the fewer the facts. As veteran news commentator Gabriel Heatter observed upon the outbreak of World War II, "In time of war, the first casualty is truth."

So, inevitably, those wishing "to prove" something are as likely as not to end up with homemade evidence, if they are not on their guard.

WHAT'S WRONG WITH "HOME AND MOTHER"?

There are at least two factions in any assembly—call them the builder-uppers and the breaker-downers; the professional and the practical; the givers and the takers, if you will.

From the long range aspect this, or any other point of difference, is deplorable. True strength lies in going ahead toward a high level goal. We are reminded of an old simile; add a bucket of typhoid-polluted water to a reservoir of pure water and you end up with all typhoid; add a bucket of pure water to a reservoir that is typhoid-polluted and it all remains typhoid.

It takes truly endlessly unrelenting strengths to produce a superior thing which small, careless efforts can destroy.

We should leave mediocrity to the mediocre.

Edward R Searles
Editor

Don't just order "copper," specify "Anaconda."

Anaconda Copper Tube is the logical choice for air conditioning and refrigeration applications because it has excellent corrosion resistance and heat transfer properties; it can be formed and fabricated easily; it is suitable for making soldered, brazed and flared-tube joints; it can be provided in specified tempers.

You will find Anaconda's new ACR Copper Tube excellent for conveying refrigerants. It is sold cleaned, dried, capped, color-coded and marked ACR . . . in 20-foot straight lengths, hard temper, Type L, in sizes from ⅜" O.D. through 6⅛" O.D.

Anaconda Copper Refrigeration Tube is available in 50 and 100 ft. coils in sizes from ⅛" O.D. through 1⅝" O.D., dehydrated, ends sealed, and uniformly soft temper.

We also offer a complete range of types and sizes of Anaconda Wrought-Copper Fittings for refrigeration and air conditioning work. To be sure of a top-quality installation, specify Anaconda Tube AND Anaconda Fittings.

For complete information about Anaconda Copper Tube and Fittings, write for free copy of Publication B-1, Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 61-729

ANACONDA®

COPPER TUBE AND FITTINGS

FOR REFRIGERATION AND AIR CONDITIONING

Anaconda American Brass Company

For

Comfortable, Uniform Environment

draftless, variation-free

Air motion and movement have been the subject of ASHRAE and industry-sponsored research for many years. Results of these studies have proven to be useful to the air conditioning engineer. However, the design of a room air distribution system remains largely an art requiring design decisions based on judgment and experience. The system must be designed not only to absorb the proper heating or cooling load and provide proper ventilation, but must also distribute the conditioned air to provide a comfortable uniform environment, without drafts or large temperature variations.

Factors which affect the distribution of conditioned air within a space can be grouped as (1) primary air pattern and (2) space or room characteristics.

Primary air, for this paper, is defined as the air delivered to the room through the supply duct plus the entrained room air that lies within an envelope of arbitrary velocity, usually 150 to 200 fpm. Characteristics which determine the primary air pattern are throw, drop and spread (see Fig. 1). Throw is determined by the outlet velocity, the effective area of the air stream at its discharge from the grille, an experimental constant for the grille and the velocity used to define the boundary of the jet, the terminal velocity.

$$X = \frac{V_o K A_o}{V_t}$$

RALPH G. NEVINS
Member ASHRAE

where

X = throw, ft
V_o = outlet velocity, fpm
K = throw constant
A_o = effective area of the air stream, sq ft
V_t = arbitrary jet boundary velocity, fpm

The drop of the primary air pattern is dependent on the outlet velocity, the difference between the supply air temperature and the space temperature, and the horizontal vane setting. The spread of the primary air pattern is dependent on the setting of the vertical vanes and the type of outlet.

Experimental and analytical work of Tuve and Koestel at Case Institute of Technology,* Nottage at the ASHRAE Laboratory* and Helander at Kansas State University* is valuable to the understanding of air flow from grilles, slots, radial outlets and nozzles. Using data contained in these papers, it is possible to calculate, within the limits, the: velocity distribution along the jet axis; velocity profiles at any cross section in the fully turbulent zone; divergence angle; vertical drop; entrainment ratios; throws for several types of outlets; values of K for several types of outlets.

Correlation of the air distribution data of several investigators was obtained by Koestel** using the following equation:

$$(\Delta t_o \beta g D_o / V_o^2) [(a/b + 1)/6K] (X/D_o)^3 = \pm (Y/D_o)$$

where

Δt_o = air temperature difference at outlet, F
β = coefficient of expansion
g = acceleration due to gravity, ft/sec²
D_o = nozzle diameter, ft
V_o = outlet velocity, ft/sec
K = constant
a = shape factor for velocity profile
b = shape factor for temperature profile
X = horizontal distance from apparent point source, ft
Y = vertical displacement of maximum velocity axis, ft
$b/a = 4/[1 + (1/Pr_t)] - 1$
Pr_t = turbulent Prandtl number (approximately 0.7)

The constant K has been found to vary with: grille velocity; percentage free area; approach to outlet; turbulence behind the outlet.

The term $\frac{V_o^2}{\Delta t_o \beta g D_o}$ is the ratio of momentum force to the buoyant force at the outlet. Several simplifying assumptions are necessary for a solution to this equation, including the assumption that the slope of the jet trajectory is not too great.

Ralph G. Nevins is Professor and Head, Mechanical Engineering Department, Kansas State University.

This paper was presented as "Air Motion and Movement" at the Air Conditioning Symposium at the ASHRAE Semiannual Meeting in Chicago, February 13-16, 1961.

*See bibliography of literature on air distribution research, ASHRAE HEATING VENTILATING AIR CONDITIONING GUIDE, 1960, Volume 38, page 291.

**Koestel, A., Paths of Horizontally Projected Heated and Chilled Air Jets, ASHAE TRANSACTIONS, Vol. 61, 1955, page 213.

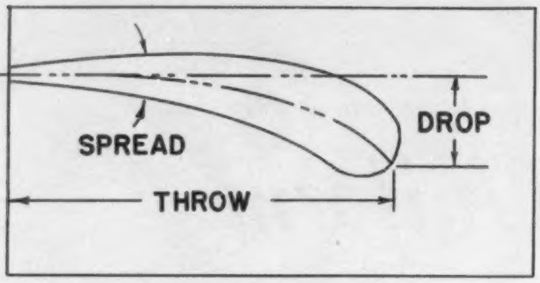


Fig. 1 Primary air pattern

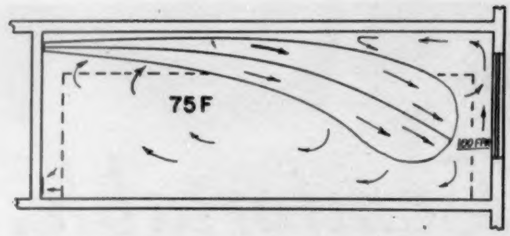


Fig. 2 Primary air pattern calculated from Koestel's equation

To illustrate the use of Koestel's equation, the path of a horizontally projected jet was calculated using the following assumptions (Fig. 2).

12 × 6 grille 40-deg spread $N_{Pr_t} = 0.7$
$V_o = 800$ fpm $\Delta t_o = 20$ F $K = 3.5$

Using the results of this calculation and assuming a terminal velocity of 100 fpm, the primary air pattern is approximated on a scale drawing of a hypothetical room. An estimate was made of the natural convection currents and stagnant zone. The interaction of these air motions determines the total room-air distribution pattern.

A similar method of estimating the performance of a given air distribution system resulted from a considerable amount of research conducted at the University of Illinois by Straub, Gilman and others. From the results of these studies, a proposed step-by-step procedure is suggested:

1. Show primary air pattern
2. Total air pattern
3. Stagnant layer
4. Natural convection currents
5. Return air pattern
6. Room air patterns

These patterns are estimated from their data which includes over 100 different experimental arrangements involving floor, baseboard and side wall registers. Both heating and cooling data are available. By superimposing the experimental patterns on a drawing of the proposed application, an approximation of the room air distribution can be obtained (see Figs. 3 and 4).

These methods do not lend themselves for evaluation of room air distribution if room characteristics involve obstructions such as beamed ceilings, short room length and furniture. In these cases, intuition and experience must still play an important part in the design of the system that may be developed.

However, in an attempt to overcome this difficulty, a study of the use of scale model rooms and distribution systems has been undertaken at Kansas State University. Using a model room with clear plastics walls and ceilings, motion pictures are taken as smoke is introduced into the room through a scale model grille. Currently the films are being analyzed to obtain the data necessary to correlate the model results with full scale results.

These data include throw, drop, initial buoyancy force and initial momentum force.

If the scaling factors can be determined, the evaluation of a given room distribution system in a given room configuration can be obtained. The effects of furniture, hallways, backwall drafts, etc., can be determined prior to installation of the system.

A

B

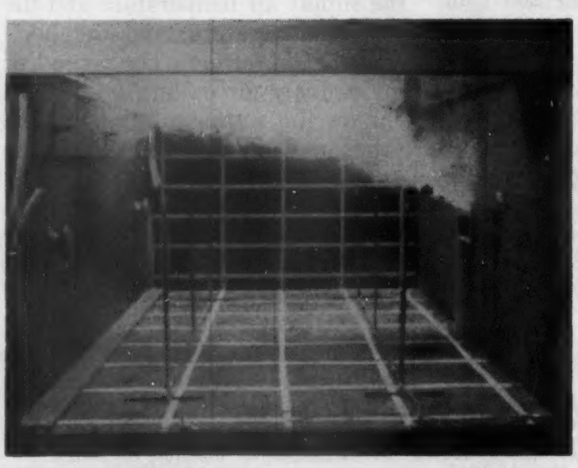
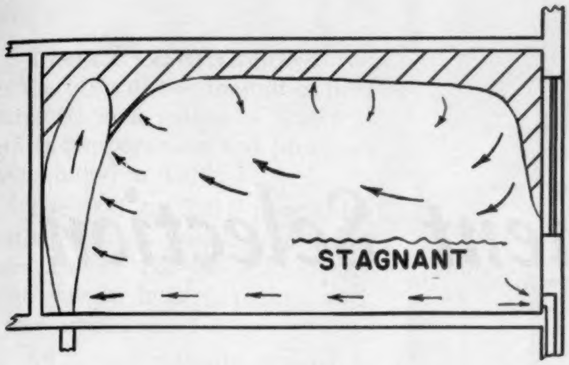


Fig. 5 Single-frame prints of movie film from Sequence A and Sequence B



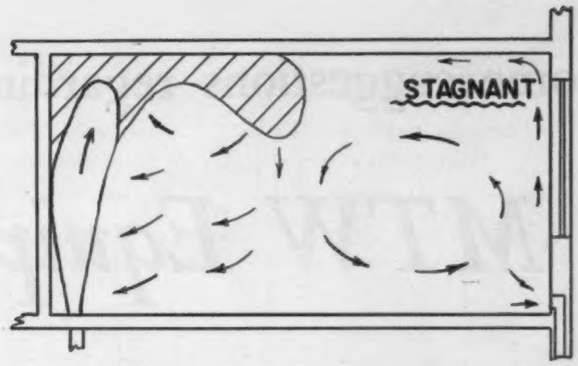


Fig. 3 Heating* **Fig. 4 Cooling***

***University of Illinois Data. Engineering Experiment Station Bulletins Nos. 435 and 442. Distribution of Air Within a Room for Year-Round Air Conditioning—Part I and Part II, Straub, et al.**

An example of the type of data being obtained is shown in Fig. 5. Both horizontal and vertical shots were taken.

Sequence A (9-7-2):* 0-deg grille setting, no vertical louvers; 1.0 cpm (9.6 air changes per hour); medium-size room (representing 20 x 20 x 8); 7 F temperature difference between room air and inlet air. One notable feature of this sequence is the action of a low flow rate dropping to the floor of the room (rather than dispersion through the room). This action was typical of all sequences involving the low flow rate.

Sequence B (9-8-3): 30-deg grille setting, no vertical louvers; 2.0 cpm (32 air changes per hour); small-size room (representing 20 x 12 x 8); 10 F temperature difference between room air and inlet air. This sequence shows how a high velocity jet initially aimed at the ceiling will ricochet off the ceiling, far wall, and floor, with resulting high velocities in the occupied zone.

*Note: All films taken at 32 frames/sec.

Final evaluation of a specific air distribution system must necessarily be dependent on comfort criteria which have been established over the years. A successful distribution system will have no objectionable drafts, the air velocities will have a maximum velocity of 50 fpm, and the vertical air temperature difference will be less than 3 F.

Whether or not the system will cause the occupants of the space to complain can presently be determined from data obtained by Dr. Houghten in 1938.* These results relate the percentage of the subjects objecting to drafts on the neck in air conditioned rooms with the air velocity and the temperature difference. For example, if the temperature difference at a point is 2 F with a velocity of 25 fpm, Houghten's data show that 10 per cent of the occupants would object; if the velocity were 40 fpm, 20 per cent of the occupants would object to the draft.

Other evaluation criteria are that: there shall be but small temperature variations throughout the occupied zone; the air motion should be 20 to 50 fpm; there should be no stagnant air zones within the occupied zone; and there should be no excessive velocities in the occupied zone. Basically, these four conditions must be met by any air distribution system if it is to give a satisfactory performance.

The comfort criteria are based on research conducted in the 1930's. Current information is needed. The proposed Environmental Research program of the Society includes plans for research to evaluate the effects of air velocity on comfort.* Future improvement in air distribution systems is dependent on continued research by industry and cooperating institutions with the encouragement and support of ASHRAE.

*Houghten, F. C., Gutberlet, C. and Witkowski, E.: Draft Temperatures and Velocities in Relation to Skin Temperatures and Feeling of Warmth, ASHVE TRANSACTIONS, Vol. 44, 1938, page 289.

*Nevins, R. G. and Humphreys, C. M., Proposed Environmental Studies in the ASHRAE Research Program, ASHRAE JOURNAL, Vol. 3, No. 1, Jan. 1961, pp. 63-65.

Some suggestions regarding

MTW Equipment Selection

Following an analysis of LTW systems, as designed by us for 22 years, it was decided to raise water temperatures and take the possible subsequent temperature drops within all standardly manufactured 125-psig equipment. This temperature and pressure analysis resulted in the 300 F range or MTW.

Many questions had to be answered and determinations made:

1. How simple can the design of medium temperature water systems be?
2. How are fuel savings claimed for space heating with medium temperature water as compared to heating with other temperatures or media substantiated?
3. What are the basic design requirements of the medium temperature water systems?
4. What are the various methods of pressurizing a medium temperature water system?
5. What is the difference in the equipment required?
6. Why is there no danger from the escaping hot water if a pipe is fractured?

These questions have been answered as follows:

Medium temperature water heating system equipment is quite simple, both in arrangement and size.

Basically, such a system is as simple as any low temperature hot water heating installation. A hot water boiler, circulating pump that circulates water through the boiler and the system simultaneously and an expansion drum floating on the line, form the nucleus of a hot water heating system. Pressure in the system is determined by the hydraulic head of the system and the operating temperature. Most hot water heating systems, therefore, are mechanically pressurized. In a LTW system the pressure of the municipal water supply line creates the necessary initial water pressure. As the water expands due to the heat input, the air in the expansion drum is compressed, increasing pressure in ratio to temperature rise. Medium temperature water systems, especially for space heating, are essentially just as simple in basic design and operation.

RAY M. HARMON, JR.

Comparing medium temperature water to LTW for space heating and process work requires an analysis that should be separated into several phases.

Table I

Operating Temp.	Operating Pressure Psig	Total Heat Btu/Gal
220	2	1490
240	10	1640
260	20	1790
280	35	1920
300	52	2060
320	75	2180
340	103	2320
360	138	2440
380	181	2570
400	232	2680

Savings to be accomplished are the result of a number of economies that are effected when designing for medium temperature hot water heating in lieu of LTW systems.

First Phase – Thermodynamics of the subject. Thermal losses in the liquid cycle of a medium temperature water system are those of radiation from piping and equipment. Heat transfer processes must always balance since all heat not consumed (in some manner) is returned to the boiler.

Second Phase – Determination of the most economical temperature drop in the primary circuit. Usually if temperatures are limited to MTW (300 F) it is possible to obtain the most economical distribution system by using the highest temperature drop possible. In all heat consuming devices it is usually a good criterion to assume a minimum of 20 F higher leaving distribution water than the required temperature in the secondary circuit. As an example, if it were required that 2 lb steam at 220 F be generated indirectly from the 300 F primary circuit, the generator would be supplied with 300 F water and return at 240 F minimum. Therefore, the generator transfer surface would be designed for a 60 F temperature difference on the primary circuit.

Third Phase–Select the equipment required of various types for the secondary circuit utilizing readily available and standard equipment to its fullest extent with maximum temperature drops. Select the method of pressurization to be used and pressure required. Discussion of this phase will be covered herein, later.

Ray M. Harmon, Jr., is President, Harmon & Beckett, Inc. & Associates, consulting engineers. This paper was presented at the ASHRAE MTW Symposium as "Equipment Selection and Pressurization." It is published here in somewhat abridged form.

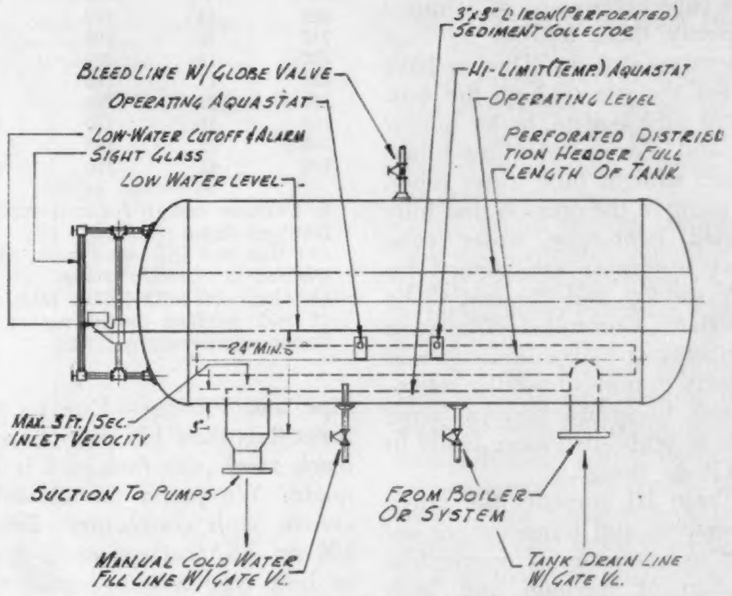


Fig. 1 Steam pressurizing may be accomplished as here shown for a MTW system

DIRECT COMPARISONS

Comparisons of the amount of heat contained in a gallon of water at various temperatures and pressures are included in Table I.

The 300 to 320 F range for heating which allows, in most cases, use of 125-psi W.P. equipment, valves, boilers, pumps, etc., is recommended.

An actual example applied to a 300 F maximum temperature with 100 F temperature drop compared to a low temperature system at 220 F and a 20 F drop (known as a standard system) to supply a 1,000 MBH Btu building heating system. 1,000,000 Btu/hr ÷ (8 lb/gal × 20 F drop × 60 min/hr) = 104 gpm. 1,000,000 Btu/hr ÷ (7.65 × 100 F × 60) = 21.8 gpm.

From Table II, it can be seen that fewer gpm are needed to transfer the amount of required heat, smaller pipe sizes and the smaller pump horsepower. This also indicates less costly pipe insulation, valves and controls. All reflect directly back to original cost.

Table II

Heat Load Btu/hr	Operating Temp F	Temp Drop F	Gpm	Pipe Size in.	Pump Head ft	Pump hp
1,000,000	220	20	104	3	50	3
1,000,000	300	100	21.8	1½	50	½

Safety of medium temperature water systems – Explanation of the reaction that takes place with circulating hot water when a medium temperature water system line under operation springs a leak due to a pipe fracture, whether it is a crack, break or blowout will be as follows:

Comparison here is made with steam since many people believe MTW to be less safe than steam. For example, select an operating water pressure of 81 psig. The pressure of 81 lb gauge corresponds to approximately 96 absolute pressure.

96 psi absolute pressure is equivalent to 325 F temperature.

Heat of saturated liquid at this pressure is 295 Btu.

Heat required for evaporation, 891 Btu.

Total heat of saturated vapor, 1186 Btu.

From the above it can be seen that the heat of the liquid at 96 psi is 295 Btu/lb. To flash this liquid into steam, an additional 891 Btu/lb will be required. Therefore, water under the cited conditions would contain but approximately 1/3 the amount of heat as steam at the same temperature and pressure.

Under the cited conditions when the hot water is suddenly released to atmospheric pressure, only the difference between 212 F, equivalent to 180.7 Btu (enthalpy of sat. liquid) and 32 F, equivalent to zero (0) Btu (enthalpy of sat. liquid), which would be 180.7 Btu deducted from 295 Btu (enthalpy of sat. liquid) at 96 psia would release 115 Btu. This energy would be expended by breaking the liquid mass into fog similar to water vapor particles, which in turn would give off heat from 212 F down to space temperature. Further cooling would tend to reunite the small globules of water into larger particles, thus further reducing the energy contained in the hot water. Entrainment of space temperature air due to the venturi effects cools the resultant steam further. Steam (already expanded) would release 1186 Btu/lb or 10 times.

One of the more actively followed Symposiums at the ASHRAE Semiannual Meeting in Chicago, January 13-16, 1961, was upon Medium Temperature Water Heating Systems.

There were four speakers at this Symposium. The paper of Homer Bird "Pipe and Pump Size Reduction" appeared in somewhat condensed form in the JOURNAL for April; that of S. W. Miller "Heat Transfer—Effect of Increased Temperature Drop in Valve Control" was in our May issue; and, "Effect of System Temperature on Pump Curve and Pressure-Drop Curve" by G. F. Carlson was in June.

Specific equipment selections: Boilers — We are proponents of water tube boilers and so continue to specify them for our medium temperature systems. Thus we have avoided the use of high fire box, vertical tube boilers, boiler burner type and marine type fire tubes, inclined straight tube water tubes, etc., being of the opinion that fully enclosed bent-tube water tube boilers are most satisfactory for MTW service, and the cost to be no higher. Controlled circulation by orificing or hydraulic balance is necessary to prevent tubular steaming and to assure uniform flow; this is accomplished more easily in water tube design.

Table III presents the range of pressures and temperatures selected as measures of economical operation of medium and high temperature water systems.

A series of three 8-hr test periods under conditions of 25, 50 and 100 per cent of load capacity indicate overall efficiency ratings at various loads of water tube boilers.

Boiler Load Per Cent	Efficiency Per Cent
25	80.6
50	81.7
100	81.1

The overall efficiency demonstrated in these tests was practically constant over all three ranges of boiler operation. The flat efficiency curve resulting from these tests, with loads from 25 to 100 per cent of boiler capacity, demonstrates the practicability of this design of boiler for the production of medium temperature water heating systems.

In actual operation, the heating load of a plant supplying a multiplicity of separate buildings will vary from 100 down to 10 per cent of capacity, hence the importance of high efficiencies at less than full load.

Seasonal variations can be as much as indicated in Table IV.

Variable burner control of a minimum of 3 to 1 ratio is required to match the capacity to the load. Following are recommended boiler design and specification criteria:

1. Controlled circulation.
2. Maximum P. D. of 10 psig.
3. No steaming space to be contained within the boiler.
4. Certified by manufacturer for MTW service (power service).
5. Tubes in transfer zone designed for upflow only.

Table III

Temp F	Pressure Psig	Temp F	Pressure Psig
200	15	280	50
210	15	290	58
220	18	300	67
230	21	310	78
240	25	320	90
250	30	330	104
260	35	340	118
270	42	350	135

6. Furnace design for non-impingement of flame on tubes.
(a) Gas and Oil—max input of 125 mbh/sq ft of rad. surface.
(b) Coal—95 mbh to 105 mbh/sq ft of rad. surface depending on ash fusion temperature.

Pipe and Fittings — Due to pressures (less than 125 psig) standard black steel pipe (Sch. 40) is adequate. We prefer an all welded system with connections flanged, 150 psi ASA carbon steel. Socket or butt type welding, small sizes bent, larger sizes use weld-fitting, take-offs with weldolets or weld fittings. Fittings for small piping in equipment rooms may be used (150 psi, cast steel) if properly installed but not recommended.

Valves and Fittings — Bronze trimmed valves are not considered satisfactory. Considerable savings may be made by using cast steel valves, buttweld type, using flanges only when absolutely necessary at pumps, boilers, etc. Positive shut-off points should be provided with gate valves.

Pump Selections — Pump selection was covered quite thoroughly in other papers presented at the MTW Symposium. However, location of the pump is important and depends upon the type of pressurization utilized, to be covered herein, later.

Mechanical seals are necessary for a tight system. Many types of seals are used satisfactorily. Location of the pump is preferably at the lowest water temperature (return) and where the NPSH is greatest. These conditions cannot always be met, hence, the occasional requirement for water cooled pumps.

Table IV

Seasons	Boilers (Million Btu/hr)	Per Cent of Boiler Capacity
Winter—Nov.-Mar. 5 Mos.	2 at 50	80
Spring—April-May 2 Mos.	1 at 50	50
Summer—June-Aug. 3 Mos.	1 at 50	20
Fall—Sept.-Oct. 2 Mos.	1 at 50	40

Pressurization — This is absolutely necessary when the water temperature at any point in the system is above the boiling point.

An elevated storage tank is the simplest means of pressurizing. This usually is not practical because of the great height required for the pressures encountered.

A hydraulic pump may be used to impose an artificial head on the system. As water volume and pressure increase due to thermal expansion, an automatic control valve will relieve the system to an open receiver and be reinjected by the pump upon temperature decrease.

The most common means of pressurizing is with a steam cushion in a separate accumulator.

Recent new developments in packaged nitrogen systems are doing much to stabilize pressures, reduce costs and simplify installation.

Steam Pressurizing (Fig. 1) — A comparison of the two latter methods follows:

Temperature and pressure are interdependent physical phenomena with no separation possible, hence over-pressurization for safety against flashout is difficult to obtain.

The mass of water in the compression tank is hot and adds as much as 10 to 15 per cent to the expansion volume, requiring a larger tank.

Compression tank by necessity requires internal distributors, mixing devices, safety valves, blow-off connections and a large number of reinforced nozzles.

Water level may be maintained within reasonably close limits.

Air must be vented from the compression tank before steam can occur if boilers stand at a higher elevation than the distribution system. If boilers are at a lower elevation than the distribution system, a flooded compression tank will occur prior to firing. The system must then be manually valved off, the tank drained to a point where steam can be produced before the system circulation can be achieved.

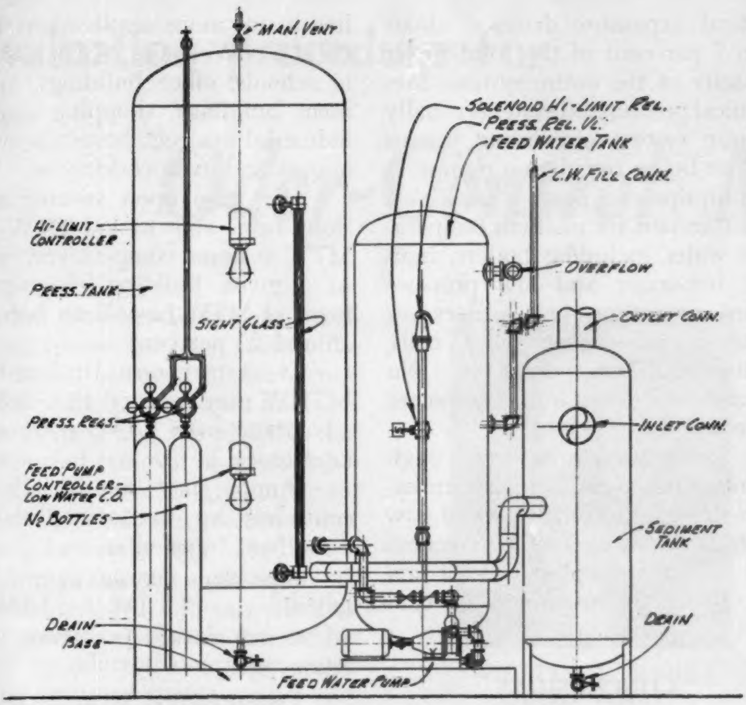


Fig. 2 Gas pressurizing, cited herein as used with a great degree of success, may be arranged as shown

Whenever firing is stopped with the steam pressured system, a vacuum will occur in the compression tank unless relieved by allowing air to return into the tank. Air is a contaminant and is not to be allowed in the system.

Steam formation in the tank, caused by flashing due to reduced pressure, will increase during certain periods. An excess quantity of water returned at lower temperature directly to the cushion tank will cause partial condensation of the pressure cushion. To maintain the pressure, the boiler must add heat to flash off additional steam.

The compression tank must be insulated heavily to minimize the heat loss by radiation as all the hot water in the system flows through the tank. The steam balanced system requires a steam pressurized expansion drum, usually horizontal, equipped with the following:

Internals: Perforated horizontal inlet pipes, vertical outlet pipes with anti-vortex fittings and vertical drain pipes.

Valves and Trim: Thermometers, pressure gage, test wells, relief (safety) valves, tandem blow-off valves, gate valves, three column water gage and vents.

Controls: Level control, overflow control, feed water control and emergency feed water control.

Tanks of larger diameter work much more satisfactorily; best aspect ratio is about 3.5 to 1. The water capacity of the horizontal expansion drum is based on the normal operating water level in the drum being approximately at three-fifths of the vertical height. The volume of water at this level should be from 10 to 15 per cent of the total capacity of the entire system.

Some steam balanced systems require two sets of pumps, boiler circulating pumps and distribution system circulating pumps, depending on total system friction head.

Air: Some systems have used compressed air for superficial pressurization. One of the best components for corrosion is oxygen. Utilizing air adds oxygen to the system and is not recommended.

Gas Pressurization (Fig. 2) – This has been used with a great degree of success. Following are five methods of mechanical pressurizing with nitrogen utilizing compression tanks:

Use a vertical, single compression tank with low and high pressure receivers with a small compressor or bottled gas for a pressure source.

Dual vertical compression tanks, one for cushioning and one for pressure relief.

A single vertical compression tank and sealed storage tank for excess water. Both tanks on same floor level utilizing a head pump for pressurization.

A single vertical compression tank and overhead vented storage tank for excess water using a pump to return water to system and pressurization.

A single vertical compression tank with by-pass control of hot water at each heated building permits indicating anticipated heating requirements to the central heating plant. This latter system permits control of heat input to each boiler so as to maintain fairly close tolerance in water temperature range, thus holding the water expansion within the volume limits of the compression tank.

Features of the Nitrogen System include: This system involves the use of a compression tank containing a fixed quantity of inert gas; no system water flows through the tank; the tank floats on the return main by means of a small interconnecting balance line; the balance line is so piped to avoid thermal convection and heating of the tank; gas pressure is applied to the cushion space in an amount predicted by the system design; and the pressure must correspond to the maximum static liquid head on the system, plus a margin of safety above the saturated liquid point.

The tank may be located on the floor, eliminating pipe supports, no internals are required, insulation is not required since the system water does not flow through the tank. The size of the tank is in most cases less than one-half that required by a steam blanket system. Past experience indicates a manufactured, packaged nitrogen system costs about the same as the steam blanket surge drum, but the nitrogen package includes level controllers, sediment and air collector, boiler feed pump, safety controls and boiler feed tank, completely assembled. The above are not included in the steam blanket surge drum. It is possible to eliminate oxygen completely from such a system, the worst nemesis of

MTHW or HTHW systems. Tanks may be sized easily if the physical and operating characteristics are known.

The basic operation of the automatic control system as it applies to the flow control of the water may be described as follows: If the water level in the nitrogen compression tank becomes too low, the water make-up pump is put in operation. Continued lowering of the water level will energize an alarm and close the safety shut-off valve in the fuel lines. When the level rises too high in the compression tank, a high level relief valve will be opened to release water to the make-up tank.

The mechanical pressurized system requires a vertical expansion drum pressurized with nitrogen and equipped with only the following: 1 level control, 1 water gauge, 1 relief valve, 1 drain and 1 nitrogen line.

The volume of water in the vertical expansion drum is about 5 to 7 per cent of the total water capacity of the entire system. Mechanical pressurized systems usually require system circulating pumps and no boiler circulating pumps.

Equipment now is available as a standard for medium temperature water including boilers, indirect hot-water and low pressure steam generators, unit heaters, air handling equipment, blast coils, fin-tube radiation, pumps, etc. No specialized custom built equipment is required.

The tendency by some engineers seems to be to install an extremely complicated system of flow controls. Analyze your flow system and plan the simplest control layout, using the minimum of controls.

CONCLUSIONS

The approach used seems to be primary with minimal educational requirements, most economical and has many more applications than HTHW. We have MTW systems in schools, office buildings, apartment buildings, shopping centers, industrial projects, hospitals, warehouses and even residences.

We have upon several occasions been able to bid LTW and MTW systems competitively within a given building. Savings in favor of MTW have been between 18 and 22 per cent.

It is our conclusion that MTHW may be used to a definite advantage over LTW systems, in most cases.

Pumps may require 75 per cent less hp to accomplish the same heat transfer.

Pipe sizes may be as much as half the size of LTW systems with additional savings in valves, insulation, etc.

Pressurization is quite important to eliminate flashout, pump cavitation and to purge the system of air.

BULLETINS

Corrosion Resistance. Supplementing Bulletins Nos. 1, which outlines a simplified theory of venting and principles of double-wall gas vent operation, and 2, which covers advantages to be gained by use of Type B double-wall metal vents in place of Type C single-wall pipe for vent connectors, four-page Bulletin No. 3 describes corrosion-resistant properties of double-wall gas venting materials. Future releases will cover other phases of gas venting.
Gas Vent Institute, 333 N. Michigan Ave., Chicago 1, Ill.

Dust Spot Test. Explained in Flyer B-5210 is why the soiling effect of air is a useful index to its dust content and how this index is used to determine the efficiency of air cleaners in the U. S. Bureau of Standards Dust Spot Test. Included are references to other bulletins on various aspects of electronic air cleaning.
Westinghouse Electric Corporation, Sturtevant Div, Damon St., Hyde Park, Boston 36, Mass.

Ball Valves. Information on manually and pneumatically-operated ball valves in sizes from ¼ through 12 in. is presented in 32-page Catalog 1200. Valves with screwed, socket weld and flanged ends are listed for temperatures from −150 to 600 F, pressures to 1000 psig and vacuum to 10^{-6} mm Hg.

Two basic types of valves are catalogued in detail: a top-entry valve which may be opened for inspection or repair without removing the body from the line and a valve with one-piece bar stock body and end adapters. Diagrams illustrate self-adjusting seats. Standard body materials listed are carbon steel, stainless steel, bronze, aluminum and solid PVC. Standard seat materials are Teflon, reinforced Teflon, Buna-N and neoprene.

Dimensions and weights, material specifications, typical C_v values and pressure-temperature rating charts are provided. Pneumatic operators for automatic and remote on-off operation are described and illustrated and a variety of special valves and automatic valve hookup diagrams are shown.
Hills-McCanna Company, 400 Maple Ave., Carpentersville, Ill.

Aluminum Selector. Aluminum alloy sheet, coil and blank data needed by engineers are summarized concisely in a new six-page Three-Way Design Data File. This selector may be used as a wall chart or file folder. Outlined on the principle chart are detailed data on the ten alloys used most often, including applications, strength, thermal and electrical conductivity, density, specific gravity, melting range and manufacturing limits. Reference charts show weights, tolerances, fabrication characteristics, available finishes, hardening properties and embossing designations.
Fairmont Aluminum Company, Fairmont, W. Va.

Refrigerant Indicators. Dri-Dot Moisture-Liquid Indicators for refrigeration and air conditioning systems are reviewed in Flyer 279. Briefly explained is how these units, incorporating a quick-reacting, color-changing, moisture sensitive element and leakproof fused sight glass, provide positive moisture-liquid control. Dimensions, line sizes, connection types, relative moisture concentration in system and other reference data are presented in tabular form.
American-Standard, Controls Div, 5900 Trumbull Ave., Detroit 8, Mich.

Multizone Units. Designed especially for schools, institutions and industrial and commercial buildings, WMH (horizontal) and WMV (vertical) units are presented in Catalog 58Cla. Ten sizes, from 1000 to 35,000 cfm, are available with optional filter boxes, mixing boxes and preheat coils. Outlined in the bulletin are nominal rating data, dimensions, arrangements and specifications.
Recold Corporation, 7250 E. Slauson Ave., Los Angeles 22, Calif.

Evaluation procedure for

Odor-Control Methods

Control of odors within air-conditioned spaces has been more of an art than a science. Modern engineering practice demands finer and finer control, and the effective and economical removal of odors is becoming an increasingly important factor in enclosed environments. This is especially so where the use of fresh, outdoor make-up air would be reduced to a minimum, and the recirculated indoor air picks up odors that are generated in the occupied spaces.

As part of the environmental program at the ASHRAE Research Laboratory, the study of air-conditioning odors has achieved an important position—one which should give much-needed information to the design engineer. It is the purpose of this paper to examine a procedure which can be used to evaluate odor-control methods such as odor modification, sorption and oxidation. The term modification will be used to imply either masking, counteraction or cancellation.

Possible methods of evaluation — There are numerous methods of odor evaluation and each is based on the use of the human olfactory system. A few of the possible methods are outlined as follows:

1. Use of a rating scale with numbers and word description related to the intensity of an odor.
2. The dilution technique, whereby a sample of odorous air is diluted with odor-free air until a threshold level is reached.
3. The comparison of an odor level with a series of samples of varying concentration, and matching the unknown against one of the samples.

The above can be the result of either initial, immediate impressions or evaluations made after long periods of exposure to the odorant.

WILLIAM F. KERKA
Member ASHRAE

. . . the fact that activated carbon will absorb odorous vapors has long been established. In its application there are a number of problems that must be considered . . .

. . . once a test condition is set up, absolute stability during the period of evaluation may not exist . . .

. . . to gain a better perspective of the treatment time necessary for odor reduction, studies with cigar smoke odor were made . . .

. . . studies using iso-valeric acid vapor were conducted over a longer period of operation time . . . to assure an adequate reaction time between the ozone and the malodor . . .

TYPES OF ENVIRONMENTS

Studies made under actual field conditions; for example, in the occupied space of a building. Non-simulated, in-space, dynamic system.

Use of test rooms where the environmental conditions (temperature, humidity and odor concentration) can be controlled carefully. Simulated, in-space, static or dynamic system.

Odorous environment confined to an air stream with evaluations made at sniff ports. A dynamic, out-of-space, simulated system.

Confining the odorous air in containers, syringes, etc., for evaluation. A static, out-of-space, simulated system.

Many authorities in the field of odor research agree that the best way to evaluate odor intensity is to have the person (or at least the person's head) completely surrounded by the environment.[1]

The two 8 x 12 x 8-ft odor test rooms[2] at the ASHRAE Laboratory were found to meet this condition, and the complete air-conditioning system to each test space assured accurate control of the environments. In selecting a method of odor evaluation, it was concluded that a panel of from four to eight persons making a direct and immediate appraisal of the environment with a rating scale could obtain the most data in the least amount of time.

Odor-control methods and odorants selected for study — A survey of manufacturers of odor-control equipment was made at the outset of the program to ascertain the availability of products on the market. The products used for study are listed in the panel below.

[1] Exponents refer to References.

Method of Odor Control	Product	Description
1. Modification	a. Product "A"	Non-reactant, volatile liquid
	b. Product "B"	Non-reactant, volatile liquid
2. Sorption	a. Activated coconut-shell carbon	Granular #6x 10 mesh, 50-min accelerated service life by U. S. Government chloropicrin test
3. Oxidation	a. Ozone from small ozone - generating lamps	O_3, Gas

William F. Kerka is a Research Engineer at ASHRAE Laboratory. This paper was presented at the ASHRAE 68th Annual Meeting, Denver, Colo., June 26-28, 1961.

The following odorants were selected in the order of their importance, tobacco smoke usually being the most common offender in odor problems. It was also desirable to choose three different types of odorants — natural, synthetic multi-component and synthetic single-component.

Odorants	Description
1. Fresh Cigarette Smoke	Generated by mechanical puffer. A natural odor.
2. Synthetic Kitchen Malodor[3]	Composed of a mixture of pure compounds and essential oils. A synthetic, multi-component odor.
3. Iso-Valeric Acid	A pure vapor which resembles the smell of body odor. A synthetic, single-component odor.

Odor introduction apparatus — Apparatus used for producing cigarette smoke is shown in Fig. 1. One unit was located in each of the two test rooms. The normal puffing time for a king-size, filter-tip cigarette was about 12 min, although only the first ten min of this time were used for odor introduction. The mean out-of-the-pack weight of six randomly selected cigarettes was 1.155 gm, and the mean weight loss for the ten-min burning period was 0.782 gm. Most of the visible smoke generated came from the free-burning end.

Synthetic kitchen malodor was introduced into the test rooms by evaporation from a wick dipped in a bottle of the fluid. For this purpose the full-strength odorant was diluted 50% with distilled water. The wicks and bottles were placed in the small recirculating system located in each odor room as shown in Fig. 1. In an early series of tests, the malodor was introduced in the test space by spraying from an aerosol can.

Iso-valeric acid vapor was introduced into the air supply duct to each test room by bubbling nitrogen through two gas-washing bottles coupled in series and containing the liquid acid.[2]

Operation of odor-control apparatus — Odor modifiers were introduced into the test rooms by evaporation from wicks in bottles located in the recirculating system. Because of possible fractionation during the evaporation process, the liquids (as well as the kitchen malodor) were changed for fresh batches about every fifth test.

Activated carbon in the sorption studies was used in canisters mounted on the inlet side of the fan of the small recirculating system that is shown in Fig. 1. An empty canister was used in one of the rooms so that the appearance of each room was the same to the panel member.

A mercury-vapor, ozone-generating lamp also was mounted in the recirculating system in each test room. The lamp (G.E. No. 0Z4S11) was operated in accordance with the manufacturer's specifications.

TEST PROCEDURE

The procedure used in this study was basically one of introducing a measured amount of malodor into each of the two test rooms. In one of the test rooms, the odor-control agent was allowed to act on the malodor for a given period of time, after which the odorous environments in each test space were evaluated by a group of subjects. In some preliminary studies, a rating scale that had been used in the past[2] was utilized for the evaluation of the odor levels as follows:

Level	Word Description
0	No odor
1	Threshold, recognition
2	Definite
3	Strong
4	Overpowering

However, since the odor levels normally encountered in air-conditioned spaces are seldom above the 2 or 3 level, the levels used in the study were kept within the lower portion of the scale. This, then, restricted the number of scores (even though half scores were permitted; for example, a 1½ or 2½) from which to evaluate. In order to broaden the choices for noticeable differences in level, a 0-to-10 point rating scale was adopted, with no associated word description other than the fact that 0 meant no odor, 1 was threshold (recognition threshold), and 10 was considered a maximum level.

A description of a developed test procedure is noted in the following steps (using cigarette smoke as the malodor and an odor modifier as the odor-control agent):

1. The test rooms are thoroughly purged with odor-free, conditioned air until the temperature and humidity in each test space is maintained at 75 DB and 50% relative humidity, respectively (all tests were conducted at these conditions).
2. The external air supply then is shut off and a cigarette is placed in the smoking apparatus in each test room for exactly ten min. At the beginning of the smoking period, the mixing fan (propeller fan not shown in Fig. 1) in each test space is started in order to assure complete mixing of malodor and control agent and to prevent stratification.
3. At the end of the smoking pe-

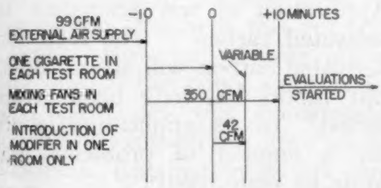
Fig. 1 Mechanical smoker and recirculating system in test room

riod, the cigarettes are removed and the bottle of odor modifier unsealed and placed in the small recirculating system of one of the rooms, and the recirculating fan turned on for a pre-determined period of time (this time determines the ratio of modifier concentration to malodor concentration). The mixing fans still operate during this period.

4. The bottle with odor modifier then is removed and the recirculating system shut off. The mixing fans continue to operate until ten min after the odor introduction was stopped.

5. After this period, the mixing fans are shut off and the subjects are called to evaluate the odor levels in each test room.

A schematic drawing of this static, batch-type test procedure is shown as follows, assuming that 0 time is the end of the odor-introduction period.



Odor evaluation procedure – Usually four runs were made during the day. The operator of the test rooms would select, at random, one or the other rooms to be treated with the odor-control agent; which room was being treated was unknown to the panel members. After the odor introduction and treatment cycles in the rooms were completed, the panel members were called. Half of the group entered one room first (one at a time) and the other half entered the other room first. The subject walked around the room at least once, sniffing several times, and then left. Upon leaving the first room (or in some cases while still in the room) he recorded on his score sheet the following odor-level impressions:

1. Over-all level – Lumped impression of items 2 and 3.
2. Malodor level – Cigarette, kitchen, or iso-valeric acid.
3. Background level–Odor modifier, activated carbon, or ozone.

After waiting for at least one

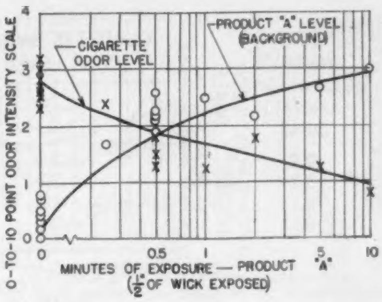


Fig. 2 Odor level of Product "A" and cigarette smoke versus exposure time of Product "A"

min, the panel member entered the other test room and went through the same procedure. The panel member was always told before a test what malodor and control agent were being used, but not, of course, which room was treated. All evaluations were made within a ten-min period or less.

The results of each test were tabulated and replicate tests were analyzed statistically (by the analysis of variance)[4] to determine if any significant reduction in the malodor level occurred when treated by the control agent. A confidence level of 95% was considered significant.

The term "background level" was simply a column heading under which the panel members scored the odor level of the modifier (Product "A" or "B") or ozone, depending on what was used for a test. During the sorption studies the panel members were instructed to seek out any odor other than the malodor and score it as the background level.

The rooms themselves (if closed for long periods of time) have a characteristic woody odor slightly above threshold level, but this was not detectable during a test run when a malodor level of from 3 to 5 (on the 0-to-10 point scale) was used, or even when it was lowered by the control agent to a level of 1 or 2. However, daily airing of the rooms and standing over the week-end with doors opened reduced this problem to a minimum. All the surfaces of the rooms were washed with mild detergent and warm water periodically.

PRESENTATION OF RESULTS

Application of test procedure using odor-modifier agents – The results of the studies on the Product "A" odor modifier and cigarette smoke are shown in Fig. 2 (a logarithmic scale was used only for convenience). To ascertain at what proportions of malodor and modifier concentration studies should be conducted for the most effective control, the concentration of the product was varied by the length of time the wick was exposed to the air stream (from 15 sec to ten min), while the concentration of cigarette smoke remained constant (one cigarette burned in each of the two test rooms). The arithmetic means of the evaluations of malodor level and Product "A" level (background) made by the panel members then were plotted to obtain two distinct curves. The curves were drawn to fit the points by "eye." The values at 0 exposure time represent the levels in the test room with cigarette malodor only, and show the range of scores from test to test when the physical concentration remained constant. At the point where the two curves crossed, additional tests were made to determine if the reduction in malodor level was statistically significant compared to the room with malodor only. The results of five runs are shown as follows:

Malodor–Cigarette smoke–one burned in each test room for ten min.

Odor-Control Agent – Product "A," 0.5-min exposure, weight loss = 0.0368 to 0.0507 gm (minimum and maximum for five runs), wick ½ in. above top of bottle.

	Cigarette Malodor Only			Cigarette Malodor plus Product "A"		
Run Number	Over-all Level	Malodor Level	Back-ground	Over-all Level	Malodor Level	Back-ground
CW-9M	2.9	2.3	0.8	3.6	1.9	1.9
CW-13M	3.2	3.0	0.4	3.2	1.8	2.3
CW-14M	3.3	2.6	0.7	3.3	1.8	2.2
CW-15M	2.9	2.6	0.3	3.1	1.3	2.6
CW-16M	2.9	2.5	0.5	3.2	1.5	2.1

Each value is the mean of five individual scores.

For the five replicate tests, the reduction in malodor level is significant by the 99% confidence level. However, there is virtually no difference in over-all level between the treated room and the room with malodor alone. To operate to the right of the crossover point (Fig. 2) further would reduce the malodor level, but only at the expense of increasing the odor level of the product above that shown in the tabulation. This would result in masking (superimposing one odor for another) rather than the counter-action (reduction in level of both malodor and odor modifier) that is desired.

The fact that some background odor level of the product was recorded in the test room with cigarette malodor only does not necessarily mean that any residual odor was present from a previous test, but could arise from the fact that some of the components of the malodor may have reminded the panel member of the product odor. It should again be pointed out that the panel member was never aware of which room was being treated. He was told also that in some special tests both rooms might or might not contain the control agent.

The same procedure of determining the crossover point of operation for Product "A" and kitchen malodor was used. The results of five runs at slightly to the left of this point showed a significant reduction in malodor level. However, the odor of the product in the treated room was again evident. To assure that the kitchen malodor was not over-treated; that is, too much odor modifier used, a series of five runs was made with a lower concentration of Product "A" (to the left of the crossover point). The analysis indicated that the reduction in malodor level was not statistically significant. On the other hand, the odor level of the product (background) in the treated room was also lower than in the preceding tests.

Application of procedure to Product "B" odor modifier—The results of the studies on Product "B" odor modifier and cigarette smoke are shown in Fig. 3. It was found that the physical concentration of this product for recognition threshold was considerably less than that of

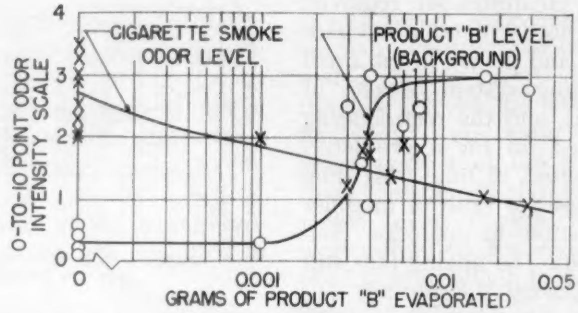


Fig. 3 Odor level of Product "B" and cigarette smoke versus weight loss of Product "B"

Product "A." The amount of Product "B" evaporated from the ½-in. exposed wick was so great that a short enough exposure time was not possible. As a result, the wick was submerged and evaporation from the surface of the liquid was utilized. Because for a given exposure time the weight loss of Product "B" varied considerably from test to test, the results are plotted on a weight-loss basis rather than on an evaporation-time basis. The six tests that were run close to the crossover point were tabulated and analyzed: Malodor — Cigarette smoke — one cigarette burned in each test room for ten min. Odor-Control Agent — Product "B," weight loss 0.0030 to 0.0061 gm, no wick exposed.

Run Number	Cigarette Malodor Only: Over-all Level	Malodor Level	Background	Cigarette Malodor plus Product "B": Over-all Level	Malodor Level	Background
CB-2M	2.6	2.5	0.2	3.4	1.4	2.9
CB-3M	2.5	2.3	0.4	3.1	1.2	3.5
CB-4M	3.4	3.3	0.2	3.7	1.7	3.0
CB-5M	3.3	3.0	0.2	3.1	1.9	2.2
CB-9M	3.7	3.5	0.1	3.3	1.8	2.5
CB-10M	3.3	3.0	0.6	2.4	2.0	0.9

Each value is mean of five individual scores.

In this study the panel members were instructed that Product "B" would be scored as the background level. Also, as in the previous runs, evaluations were begun upon the termination of the ten-min mixing period. Analysis of the data indicates that the probability of the results of the six tests occurring by chance is less than 0.001; hence, the reduction in the malodor intensity by the modifier is significant by the 99.9% confidence level. The relatively same over-all level for the treated and untreated rooms again is evident. The product level (background) in the treated room also is noticeable.

The rapid rise in the product level at the crossover point would, in actual practice, make proper control difficult; however, the exact shape of this curve needs further study.

The results of the studies on Product "B" and kitchen malodor near the crossover point again indicated a significant reduction in malodor level, but with the noticeable odor level of the product.

Application of test procedure to activated carbon — The fact that activated carbon will adsorb odorous vapors has long been established.[5] In its application, there are a number of problems that must be considered[6]:

1. Operating life — dependent, among other things, upon its rate of loading, its exposure time and the type of vapor involved.
2. Amount of treatment — the weight of activated carbon, and the amount of air and vapor treated by it to produce significant odor reduction.
3. The economics of its use — maintenance, reactivation, replacement, etc.

Items 1 and 3 are beyond the scope of this paper since they are related more to conditions in the field than to laboratory experimentation. The test procedure will, therefore, be applied to item 2.

The activated carbon was used in canister form (5 lb in a canister). The canisters were mounted on the inlet side of the fan of the recirculating system in each room as previously described. In these studies all test runs were again static, batch-type processes. No additional mixing (other than that produced by the recirculating system) was utilized in the test rooms since these tests preceded the time when it was concluded that additional mixing should be used. In a sense, however, this subjected the operation of the carbon canister to the conditions most likely encountered in actual use.

A series of four tests all run at the same treatment time was analyzed. In the case of the background level, the panel members were instructed to rate any odor other than the malodor as background. (See Table A.)

The statistical analysis of the four replicate tests indicates that the reduction in malodor level by the carbon treatment was not significant. However, it was noted that one of the panel subjects in this test series was consistently scoring opposite to the other seven members. Elimination of this person's score gave test results that showed a significant reduction in cigarette malodor by the 95% confidence level. The relatively low background level for each condition is evident in the preceding scores.

To gain a better perspective of the treatment time necessary for odor reduction, studies with cigar smoke odor were made with varying lengths of treatment time. In these tests, the cigar was burned for only 2.5 min in each test room, since it was found that this produced a high enough odor level for evaluation purposes. A tabulation showing the results of five tests with the treatment time listed in each case is presented in Table B.

Since each test has a different treatment time, an analysis of the individual tests was made instead of an aggregate analysis. The significant reduction in malodor level is noted at the 17.5-min treatment period and above. The progressively lower cigar malodor level and over-all level with increased treatment time also are evident in the room using activated carbon.

TABLE A

Run Number	Cigarette Malodor Only: Over-all Level	Malodor Level	Background	Cigarette Malodor plus Activated Carbon: Over-all Level	Malodor Level	Background
CC-1	2.9	2.8	0.1	2.2	1.9	0.8
CC-2	2.9	2.7	0.2	3.0	2.7	0.7
CC-3	2.8	2.6	0.4	2.5	1.6	1.2
CC-4	3.1	2.9	0.3	3.6	3.1	0.9

All runs have 20-min treatment period.
Each value is the mean of eight individual scores.

TABLE B

Run Number	Treatment Time Min	Cigar Malodor Only: Over-all Level	Malodor Level	Background	Cigar Malodor plus Activated Carbon: Over-all Level	Malodor Level	Background	Significance of Malodor Reduction 95% Confidence Level
MC-1	12.5	3.9	3.8	0.3	3.1	2.9	0.3	No
MC-2	17.5	3.8	3.6	0.4	3.2	2.9	0.5	Yes
MC-3	22.5	4.2	4.1	0.5	2.5	2.1	1.2	Yes
MC-4	27.5	3.4	3.2	0.7	2.6	1.9	1.1	Yes
MC-5	32.5	3.3	3.1	0.3	1.7	1.0	1.1	Yes

Each value is the mean of six to eight individual scores.

TABLE C

Run Number	Treatment Time Min	Iso-Valeric Acid Vapor Only: Over-all Level	Malodor Level	Background	Iso-Valeric Acid plus Activated Carbon: Over-all Level	Malodor Level	Background	Significance of Malodor Reduction 95% Confidence Level
VC-1	15	2.7	2.2	0.5	1.8	0.6	1.3	Yes
VC-2	15	3.2	2.4	1.1	2.5	2.1	0.6	No
VC-3	15	3.2	2.8	0.4	2.2	1.4	0.8	No
VC-4	20	2.5	2.1	0.7	1.3	0.4	1.0	Yes
VC-5	20	2.6	2.2	0.6	1.8	0.9	1.2	Yes
VC-6	25	2.4	1.8	0.8	1.9	0.8	1.3	Yes
VC-7	25	2.7	2.3	0.7	1.4	0.9	0.8	Yes

Each value is the mean of eight individual scores.

The same procedure (a different carbon canister was used for each malodor) was used in applying the test procedure to activated carbon and iso-valeric acid vapor. The supply air was introduced into each test room at a rate of 99 cfm with a malodor concentration of 0.0000218 oz/1000 cu ft (0.0053 ppm by volume) for a period of five min for each run, and the recirculation through the carbon canisters was varied from 15 to 25 min. The tabulation of seven runs is presented in Table C.

It would appear that a treatment time of 15 min was not adequate in significantly reducing the odor level of the iso-valeric acid vapor. For the 20-min period of adsorption and above, however, significant reduction in both over-all and malodor level was noted for each test run. The low background level is again evident.

In the studies treating synthetic kitchen malodor with activated carbon, a problem arose, in that, while one room was being treated, there was a natural decay of the malodor in the untreated room. This was especially noticeable if the treatment time exceeded 10 min. As a result, the panel member was comparing the treated room with the room in which natural decay of the malodor was occurring. The chances for recognizing differences would thus be lessened. There was little evidence of this rapid natural decay with the tobacco odor and the iso-valeric acid vapor. The analysis of the aggregate of six tests (treatment time, 10 to 20 min) showed the reduction in malodor level to be significant by the 99.9% level.

Application of procedure to ozone — At the beginning of the ozone studies, an evaluation of the intensity level of the generated ozone versus the operating time of the lamp (original lamps referred to as lamps A) was made. This is shown as line A in Fig. 4. Unfortunately, during this period no means of measuring the ozone concentration was available. In later studies, two other lamps (henceforth referred to

as lamps B) were used (one for each room) when the original two were found by sensory appraisal to be producing a lower level for a given operating time. The physical concentration of ozone produced by each lamp B was determined by noting the decay of a special rubber strip,[7] and also by using the oxidation-reduction principle of a potassium iodide solution.[8] The degree of decay of the rubber strip for a given time of exposure was indicative of the ozone concentration in ppm by volume. It was found that continuous operation of a lamp B in the sealed-off static test room produced an equilibrium concentration of ozone of about 0.002 to 0.003 ppm (2 to 3 ppb). This equilibrium concentration is reached after about one hour operating time of the lamp. Half this concentration is reached in approximately ten min.[9] From Fig. 4, line B, the recognition threshold level for ozone was obtained after 20 min operating time, or a physical concentration of about 0.0015 ppm. This is less than that found by other investigators.[10,11]

Virtually the same test procedure was used in the ozone studies as in the preceding studies; that is, the introduction of the malodor in each test room, and the treatment of the environment by the control agent in one of the rooms for a given period of time. It should be mentioned again that throughout the test program special runs were made unknown to the panel members, whereby either or both rooms were treated simultaneously, or both were not treated. This served to check the responsiveness of the subjects to make sure that they were not partial to either room.

The panel members were familiarized thoroughly with the odor quality of ozone generated by the lamps, and were instructed that this odor characteristic would be scored as the background in the three-component analysis method used. Seven tests using ozone from lamp A as the control agent and cigarette smoke as the malodor were run with a varying treatment time.

Run Number	Treatment Time Min	Cigarette Malodor Only: Over-all Level	Malodor Level	Back-ground	Cigarette Malodor plus Ozone: Over-all Level	Malodor Level	Back-ground
CO-2	10	2.3	2.2	0.8	2.6	1.9	1.0
CO-4	10	2.3	1.6	1.0	3.0	1.8	1.4
CO-1	15	2.1	1.9	0.7	2.0	1.0	1.8
CO-3	15	3.4	3.3	0.3	3.0	1.5	1.7
CO-6	15	3.0	2.4	0.6	2.8	2.2	1.1
CO-7	15	3.5	3.3	0.3	3.0	2.0	1.5
CO-8	20	2.9	2.6	0.4	2.8	1.4	1.8

Each value is the mean of five individual scores.

An analysis of the four replicate tests for 15 min of treatment time shows a significant reduction in cigarette malodor level. The ozone in the treated room was perceptible as shown in the last column.

The studies using iso-valeric acid vapor were conducted over a longer period of operation time (up to 55 min) of the ozone generating lamp (Lamp A) to assure an adequate reaction time between the ozone and the malodor. Instead of treating one room and comparing it with the untreated room, both rooms were treated with ozone for the first group of runs, and then both rooms were untreated for the second group of runs. The comparison, therefore, was made on this basis. The fact was not known to the panel members.

The test results for the treatment of the malodor with ozone are shown in Fig. 5. Here a direct comparison of the plotted levels was made between the rooms with iso-valeric acid vapor alone (untreated) and then with the vapor treated by the ozone. The fact that the reduction in malodor intensity due to ozone treatment is no greater than the natural decay (with time) of the malodor in the untreated rooms is evident. The slight background level of ozone reported in the untreated rooms again could arise from the fact that some of the characteristic odor notes of the malodor reminded the panel members of the ozone. The over-all intensities (not shown in Fig. 5) for both the treated and untreated rooms were about the same for each condition.

In the studies using synthetic kitchen malodor and ozone, the test procedure was identical to the one just described for iso-valeric acid except that the malodor was introduced into each room by spraying from an aerosol can for a two-sec period. The test results

Fig. 4 Odor intensity level of ozone versus operating time of ozone-generating lamp

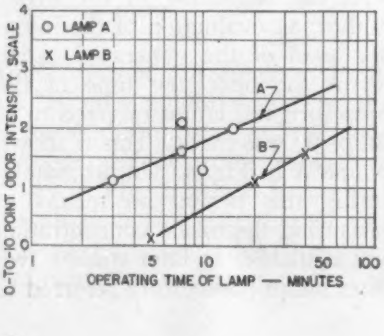
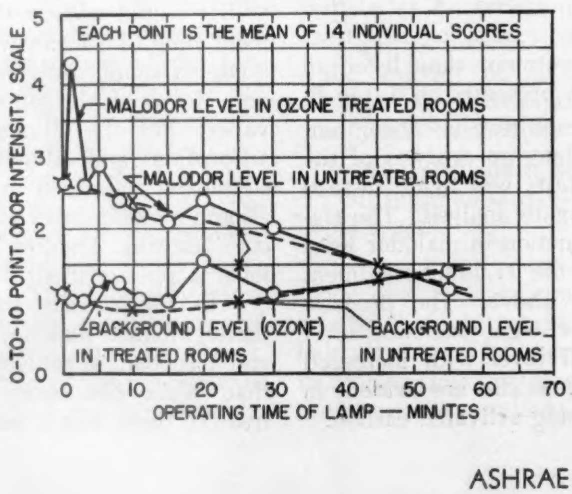


Fig. 5 Malodor level (iso-valeric acid) and ozone level in treated and untreated room versus time of ozone treatment



are plotted in Fig. 6. The abscissa in Figs. 5 and 6 (operating time for ozone lamp A) applies to the treated rooms only, the untreated rooms (with malodor alone) being allowed to stand for the same length of time before evaluations were begun.

From Fig. 6, there appears to be no significant reduction of the malodor level by the ozone as compared to the natural decay of the malodor alone, except possibly at the longest treatment time. However, here the level of ozone is so high that masking of the malodor probably takes place. The steady rise in ozone level is apparent with increased operation time of the lamp.

Test runs using ozone lamps B — When ozone lamps B were installed, a series of repeat runs was made using cigarette smoke and ozone, the latter at a concentration of about 0.002 to 0.003 ppm. The mixing fans also were used in the test rooms to comply with the test procedure recommended at the beginning of this paper. The results of four identical tests showed that there was no significant reduction of the cigarette malodor when treated with ozone as compared to the cigarette malodor alone.

Although all procedures of testing described so far are based on immediate impressions, it was concluded that possible exposure to ozone by the panel members over a period of time might cause some fatiguing of the olfactory system and hence a lower sensitivity to the malodor. To study this effect, cigarette smoke odor was generated in one of the static test rooms. The panel members entered this room (all at one time) and made an immediate evaluation of the odor level. The panel then entered the other room where they remained for exactly ten min.

In one series of tests the second room had been purged thoroughly with fresh air; and in the second series, it contained a concentration of ozone of about 0.002 to 0.003 ppm. This fact, of course, was unknown to the panel. After the ten-min exposure, the subjects re-entered the first room and again evaluated the cigarette smoke odor level. From previous studies it had been found that the odor level of cigarette smoke did not decay appreciably during the ten-min period following odor introduction. The following tabulation shows the results of this test:

Ten-min exposure in room with ozone at concentration of 0.002 to 0.003 ppm by vol			Ten-min exposure in Odor-Free Room	
	Initial Odor Level	Final Odor Level	Initial Odor Level	Final Odor Level
	3.9*	2.8	3.5	3.1
	4.0	3.0	4.4	2.8
	3.6	3.0	3.8	3.1
	4.0	3.3		
Mean of 4 Tests / Mean of 3 Tests	3.9	3.0	3.9	3.0

* **Each value is mean of four subjects.**

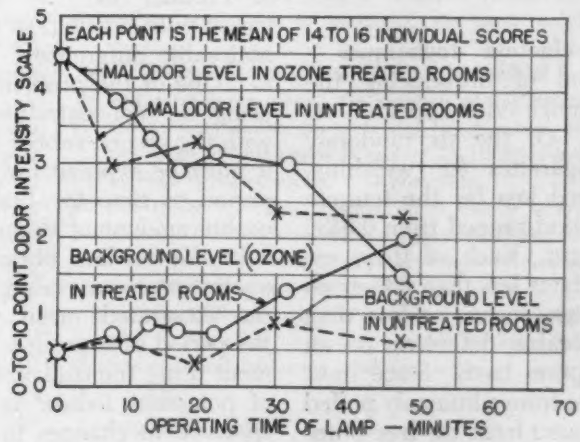
It has been noted in the past that there is a tendency for the second judgment of a given level to be lower than the first (for this reason half the subjects normally entered one room and half the other room first). This point is evident in the preceding results, but the fact that, after exposure of an ozone concentration 0.002 to 0.003 ppm, the second judgment was no lower than the one made after exposure to odor-free air, indicates that the exposure time or concentration of ozone was not great enough to cause any fatiguing of the olfactory receptors.

To further study the exposure to ozone for an extended period, the panel members remained in the test room for a ten-min period. In one case the room contained only cigarette malodor (one cigarette puffed for ten min) and in the other case ozone again at a concentration of 0.002 to 0.003 ppm was present with the malodor. Again this was unknown to the panel. The results of this study are shown in Fig. 7. Each point is the mean score of four subjects partaking in three identical tests for each condition and represents the initial cigarette malodor level and evaluations of malodor level made at one-min intervals thereafter. The effect of adaptation is evident[2] in both cases. The adaptation rate for each of the two conditions is nearly the same until about seven min, where there is a hint of a continued decline when exposed to the malodor plus ozone. It would appear that exposure to this concentration of ozone and malodor must be greater than a ten-min period before fatigue to the olfactory receptors exceeds the adaptation that occurs when exposed to the malodor alone.

DISCUSSION

Those test procedures presented in this paper were all of the static, simulated type. The main problem associated with this is that, once a test condition is set up, absolute stability during the period of evaluation may not exist. This can result from the change in character of the odorants under study due to

Fig. 6 Synthetic kitchen malodor level and ozone level in treated and untreated room versus time of ozone treatment



adsorption and desorption on the room surfaces, progressive dilution of the test room environment when the subject enters through the door from the outside, and the natural decay with time that complex odorants may exhibit. Having all the subjects enter a test room at one time would be advisable. In this study, however, the subjects (staff members of the Laboratory) were called from their normal work routine and in some cases were not able to respond immediately. Therefore, a maximum evaluation period to ten min was established during which all subjects completed the evaluation of each room, one at a time. To minimize any unstable effects, it would be necessary to establish a strict schedule of evaluation in the shortest possible time.

The advantages of the static system are that it is relatively easy to set up, and the amounts of odorant and odor-control agent introduced into the system can be measured readily. In the dynamic system, continuous control of all variables must be exercised to maintain an equilibrium condition. The described test setup can be used easily without physical alteration as a dynamic system except for its application to the study of odor control by sorption. In this case the adsorbent would have to be relocated in the air supply system and the odorant introduced upstream from this point. For the other cases, however, conditioned air is supplied continuously to the room, and controlled rates of modifier or ozone are fed into the test space through the small recirculating system located in the space. The odorant also is fed into the room at a continuous, measured rate.

Odor introduction techniques – The method of introducing the cigarette smoke odor appeared reproducible. Of the six randomly selected cigarettes for weighing, the measured loss for the ten-min burning period ranged from 0.6436 to 0.8739 gm. Each of these extremes deviates less than 33% from the 0.7820-gm mean, or less than a just-noticeable-difference on an odor-perception basis. Since most of the smoke from a humanly puffed cigarette comes from the free-burning end, the mechanical puffing action complied with this.

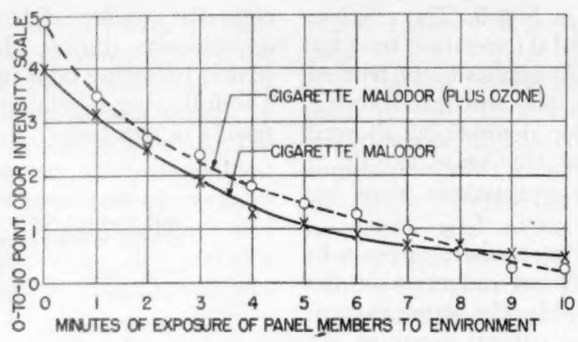


Fig. 7 Adaptation to cigarette malodor and malodor plus ozone

Concentration of the iso-valeric acid vapor could be determined accurately, and past studies[2] have shown agreement within 10% of measured and calculated values.

Introduction of the synthetic kitchen malodor by evaporation from a wick dipped in the diluted liquid proved unreliable because of fractionation. It is recommended that the liquid be aerosolized into the space for absolute reproducibility. Spraying the malodor from an aerosol can for some of the tests appeared to give a more consistent quality and level; but in addition, a means of measuring the exact weight loss should have been utilized.

Introduction and measurement of the odor-control agents – The primary purpose for introducing the odor modifiers by evaporation from a wick was to comply as closely as possible to their actual use in an air-conditioning system. It can certainly be argued that more rigid control should have been exercised. However, the method used did bring out a notable point; namely, for a given exposure time of Product "A" the weight loss varied only ±21% (less than a just-noticeable difference).

One of the problems in measuring the concentration of ozone with the special rubber strip is that it must be exposed for a sufficient period of time to obtain a measurable amount of decay. As a result, the reading obtained is not an instantaneous value, but rather the integrated mean value over the period of exposure. The instrument using the oxidation-reduction of potassium iodide[8] is readily responsive to changes in concentration, and hence gives near-instantaneous values. Witheridge and Yaglou[11] have shown that the absolute humidity affects the disappearance of ozone in a room, but since all tests in this study were made at the same condition (75DB and 50% RH) ±2.5F, the humidity effect was negligible. Also, with the low concentrations used in this study, the degeneration that occurred during the five to ten-min evaluation period after ozone introduction was stopped appears to be of small magnitude.[9]

The term "oxidation" has been used in conjunction with ozone as a possible means of odor reduction. The results of the tests conducted, especially Figs. 5 and 6, would indicate that masking probably occurs if enough ozone is generated. Further support of this fact is given in reference 11. The maximum allowable concentration of ozone recommended for long-term exposure is given as 0.1 ppm.[12] At this concentration (measurements were made near the ozone generating lamp in the recirculating system) ozone has a strong, pungent odor. Even at the measured concentrating of 0.003 ppm, the characteristic odor is quite evident and it would seem unreasonable to use much higher levels in air-conditioning systems.

Odor evaluation – In applying the test procedure, one basic fact was determined: does a reduction in malodor level occur when treated by the control agent? Although the study of odor character notes by profile analysis for blends of odorants would more completely describe the problem,[13] it cannot be denied that, if one criterion is to be chosen, the analysis of odor level stands out as one of the fore-

most. A study of the quality of the environment before and after treatment is of equal importance, but since this type of evaluation involves preference ratings, it is beyond the scope of this paper. It is planned that the examination of profile analysis and preference rating be incorporated in a future, continued study of odor control methods.

In using the three components to evaluate the levels in the odor test rooms (that is, over-all, malodor and background) the over-all level was not necessarily the arithmetic sum of the other two components. This can be resolved more clearly by considering two identical concentrations of the same odorant. For instance, if each were at a sensory level of 3, combining them (or doubling the concentration) would not give an over-all level of 6. The panel members were instructed thoroughly on this point. The use of the term "background" was perhaps not the best choice. Since one of the test rooms did not contain the control agent and one did (but in some special tests both rooms did not or both did), the choice of one term to apply to all conditions was not an easy one.

However, from continuous discussions with the panel members, there was no doubt in their minds about scoring the control agent as "background" when the agent itself had a characteristic odor. In the sorption studies the term was less definable. If the fact that some background product level was reported in the test room with only malodor resulted from the product odor being carried on the subject's or operator's clothes from the treated to untreated room, then the procedure of treating one room and not the other should be altered so that both either are treated or untreated. Comparisons would then have to be made from one test to the next rather than during the same test.

CONCLUSIONS

1. Procedure of testing described can be applied to a number of odor-control methods.
2. Main deficiency of the static type of test used is that absolute stability of the conditions may not exist during the treatment and evaluation periods.
3. Significant reduction in malodor level can be achieved by treatment with odor modifiers, but the odor of the modifier also is perceptible.
4. Significant reduction in malodor level can result from treatment with activated carbon.
5. Reduction of odor levels by ozone at concentrations slightly above threshold is not statistically conclusive by the results presented in this study.
6. Described procedures are to be considered exploratory in nature, and should serve as a guide for further experimentation in the broad field of odor control.

REFERENCES

1. Past discussions with Dr. Bernice Wenzel, University of California Medical School.
2. "Temperature and Humidity Effect on Odor Perception" by W. F. Kerka and C. M. Humphreys, HP & AC Journal Section, April, 1956, p. 129.
3. Synthetic Kitchen Malodor per specifications of General Services Administration, Federal Supply Service, in Interim Federal Spec. No. P-D-00200 (GSA-FSS) dated September 27, 1956, by C. J. D'Angio.
4. An Introduction to Statistics in the Medical Sciences, by H. C. Batson, Phd., Burgess Publishing Co., Minneapolis, 3rd Printing—1958, p. 22.
5. ASHRAE GUIDE AND DATA BOOK, 1960, Chapter 7, pp. 82-87.
6. Air Pollution Abatement Manual—Odor Measurement and Control. Mfg. Chemists Assoc., Inc., Chapter 13, page 11, by Amos Turk, Ph.D.
7. B. F. Goodrich Co., ozonometer rubber strips.
8. Most Development Co., ozone meter and recorder.
9. Communication with James R. Luck, Senior Chemist, Minneapolis-Honeywell Regulator Co.
10. Communication by Dr. Herbert Stockinger, O.H.F.H., U.S. Public Health Service.
11. "Ozone in Ventilation—Its Possibilities and Limitations" by W. N. Witheridge and C. P. Yaglou, ASHVE Transactions, 1939, Vol. 45, p. 509.
12. American Conference of Governmental Industrial Hygienists, "Threshold Limit Values for 1958", A.M.A. Archives of Industrial Health, August, 1958, pp. 178-182.
13. "Methodology of the Flavor Profile", by L. B. Sjostrom, S. E. Cairncross and J. F. Caul, Food Technology, 1957, Vol. XI No. 9 pp. 20-25.

BRITISH MEMBERS GRANTED TAX DEDUCTION ON ASHRAE DUES

Under a ruling reported May 18, 1961, by Senior Principal Inspector of Taxes, W. Walne, Inland Revenue, England, the Commissioners of Inland Revenue have approved the American Society of Heating, Refrigerating and Air Conditioning Engineers for the purposes of Section 16, Finance Act, 1958, and that the whole of the annual subscription (dues) paid by a member who qualifies for relief under that Section will be allowable as a deduction from his emoluments assessable to income tax under Schedule E.

The circumstances and manner in which they may make claims to income tax relief are: Commencing with the year to 5 April 1961, a member who is assessable to income tax under Schedule E in respect of the emoluments of an office or employment is entitled to a deduction from those emoluments of the whole of the annual subscription which is due and payable by him to the Society in the income tax year provided that—

a—the subscription is defrayed out of the emoluments of the office or employment, and,

b—the activities of the Society so far as they are directed to all or any of the following objects—

i—the advancement or spreading of knowledge (whether generally or among persons belonging to the same or similar professions or occupying the same or similar positions);

ii—the maintenance or improvement of standards of conduct and competence among the members of any profession;

iii—the indemnification or protection of members of any profession against claims in respect of liabilities incurred by them in the exercise of their profession;

are relevant to the office or employment, that is to say, the performance of the duties of the office or employment is directly affected by the knowledge concerned or involves the exercise of the profession concerned.

A member of the Society who is entitled to the relief should apply to his tax office as soon as possible for Form P358 on which to make a claim for the relief due to him.

"...for the benefit of the membership..."

JOHN EVERETTS, JR.
President ASHRAE

The fiscal year 1961-62 marks another milestone in our history. This is the beginning of the first full year of operations since the merger of our two great predecessor Societies, which was consummated on January 29, 1959, and by law required to operate on a semiannual basis until the end of the interim period.

The past two and one-half years have been rather difficult as far as the administration of our Society is concerned. The short periods of the Officers, Board of Directors, duplication of offices, and duplication of personnel have made it difficult to operate on an efficient scale compared with a unified operation which we shall now have.

As we move into our new office in the United Engineering Center this summer, we are contemplating a more efficient organization at the headquarters level, more efficient services to our membership and better communication between the National operations and the Chapter level, which is most important in a membership organization such as ours. After all, the membership makes the Society.

There are certain areas of the Society operations in which we must now make a critical review of the direction in which we must go to foster the aims and policies of our Society. In order to do this, the basic ingredient for sound progress in our Society is agreement of purpose. Agreement of thinking, our expressions, and our actions are most important so long as they are for the benefit of the membership to continue to keep our Society in the lead in our industry which it has enjoyed for many years.

There are four major divisions in our Society which are all of equal importance and which our administrative program for the next year must consider on a high priority. These are Finance, Membership, Publications and Research. These are in alphabetical order and not in order of importance. They are all important.

Our financial operations have reached the point where creeping inflation has increased our operating costs at a rate greater than the rate of income from new members, advertising and other sources. In order to give better services to the members, it has been necessary to cut certain expenditures and increase the income to augment our general income to maintain a balanced budget. Your Finance Committee has been working diligently to cut expenses and at the same time increase membership benefits, such as travel expenses to important committee meetings; the task of maintaining a balanced budget is not an easy one.

The Long Range Planning Committee is also studying ways and means to streamline a number of the operating divisions of the Society to reduce operating costs without reducing the benefits to the membership.

The problem of Membership is basic to our existence. If we had no members, we could not exist. Conversely, the stronger our membership, the stronger our Society. We now are approaching a membership of 18,000, and there are many problems at the membership or grass roots level which must be resolved. One of these is increase in membership for the Chapters as well as the Society as a whole. The Membership Development Committee is now working on a program for the Chapters to implement a membership drive to increase our membership in proportion to where it should be in relation to the advancement of our industry. This program together with the Public Relations Committee program should be available before the active operations of the Chapters this fall.

Chapter Programs as well as Chapters Regional Meetings are under study by the Regions Central Committee for improvement in these areas. Any suggestions by the Chapters or any member will be welcome.

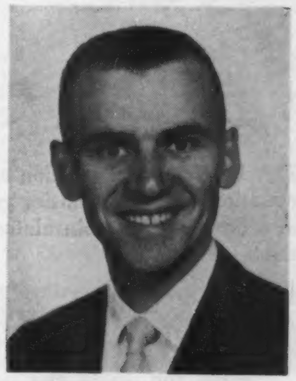
Our publications consist of four major ones, namely, the JOURNAL, the GUIDE AND DATA BOOK, the Transactions and the Standards. There are many minor publications such as Symposiums, Research Bulletins, Operational Guides, Chapter By-

(*Continued on page 75*)

Calculated Temperature Rise

in round ducts

J. RICHARD WRIGHT
Associate ASHRAE



EDWARD J. BROWN
Associate ASHRAE

Residential summer cooling applications frequently require installation of ductwork in non-air conditioned spaces such as basements, crawl spaces and attics. The conditioned air within the ducts is subject to heat gain from the non-conditioned spaces, since the ambient temperature may vary from 75 F in basements to 140 F or more in attic spaces.

An experimental investigation of heat gain to air flowing in ducts requires that the ducts be enclosed in a space throughout which a uniform air temperature may be maintained. Considerable expense would be involved to provide such a space in a laboratory, plus the controls necessary to maintain the proper conditions within the space. As an alternate means of studying the problem, the ductwork in the basement and attic of Warm Air Heating Research Residence No. 2[1] was provided with sufficient instrumentation to measure the average temperature rise of the conditioned air.

It should be noted that the instrumentation was not considered suitable for determination of heat gain by the differences in enthalpies at two stations in a duct. This would require an evaluation of temperature and velocity profiles to determine total enthalpies at each station. The Residence installation did not provide a means of controlling the ambient air temperature of the basement and attic. However, it was possible to measure the average temperature rise in the ducts after the summer air conditioner had been in operation for several hours and steady-state conditions prevailed within the basement or attic.

Several years ago, in an investigation[2] of temperature drop in ducts conveying heated air, it was shown that measurements of heat transfer coefficients (made in the Mechanical Engineering Laboratory of the University of Illinois) were in agreement with the values for the same coefficients published in the literature. Therefore, it was possible to calculate accurately the temperature drop in ducts used in forced warm air heating systems. It was assumed that similar calculations of temperature rise in ducts conveying cooled air would be valid. The measured average temperature rise data from the Residence, for a necessarily limited number of ambient temperatures, compared favorably with calculated values of temperature rise for the same ambient temperatures.

The purpose of this paper is to present an analysis of the effects of duct air temperature and velocity and ambient air temperature on the temperature rise of air flowing in round ducts used for summer air conditioning. The analysis is based on the following assumptions: (1) The heat transfer rate is constant; does not vary with time, (2) The mean radiant temperature is equal to the ambient air temperature and (3) Condensation does not occur on the exterior surface of uninsulated ducts or on the exterior vapor barrier surface of insulated ducts.

Uninsulated Ducts—Heat transfer, from the surroundings to the conditioned air flowing in a duct, depends upon the heat transfer coefficients of free convection and radiation at the outside surface of the duct and the coefficient of heat transfer of forced convection at the inside surface of the duct. The resistance to heat flow of the duct wall has been neglected because of the small thickness of the wall and the relatively large thermal conductivity of the sheet metal used in the manufacture of ducts. The heat transfer at the inside and outside surfaces must be equal when steady-state heat transfer exists. The heat balance can be expressed by the following equation:

$$q = h_i A (t_W - t_M) = (h_r + h_c) A (t_A - t_W) \quad (1)$$

where q = heat transfer, Btu/hr

h_i = inside surface coefficient of forced convection heat transfer, Btu/hr/sq ft/F

t_W = duct surface temperature, F

t_M = mean temperature of conditioned air, F

h_c = outside surface coefficient of natural convection heat transfer, Btu/hr/sq ft/F

h_r = outside surface coefficient of

J. Richard Wright is an Assistant Professor of Mechanical Engineering at the Tennessee Polytechnic Institute. Edward J. Brown is a Research Assistant Professor of Mechanical Engineering at the University of Illinois.
 This paper was presented at the ASHRAE 68th Annual Meeting, Denver, Colo., June 26-28, 1961.

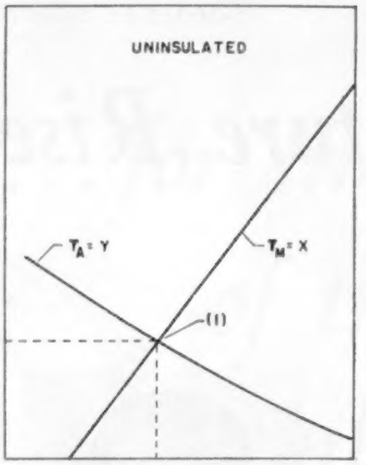


Fig. 1 Graphical solution of equation for heat transfer to air flowing in uninsulated ducts

radiant heat transfer, Btu/hr/sq ft/F

A = area of duct surface, assumed equal for inside and outside surface because of small wall thickness, sq ft

t_A = ambient temperature, F

The temperature change of the air flowing in the duct is not a linear function of duct length, but for short sections of duct the change may be considered linear. It was assumed that the temperature change would be approximately linear in a 10-ft length; therefore, the area referred to is the wall area of 10 linear ft of duct.

The solution of Equation (1) requires an evaluation of the heat transfer coefficients for assumed ambient and duct air temperatures. The inside surface coefficient of heat transfer by forced convection was evaluated by the equation for forced convection in turbulent flow in horizontal pipes found in most heat transfer texts:[3]

$$h_i = 0.023 \frac{k}{D} \left[\frac{V D \rho}{\mu}\right]^{0.8} \left[\frac{c \mu}{k}\right]^{0.4} \quad (2)$$

where

k = thermal conductivity of the fluid (air), Btu/hr/sq ft/F

D = diameter of duct, ft

V = average velocity of fluid (air), ft/sec

ρ = fluid density, lb/cu ft, standard conditions

μ = dynamic viscosity of fluid, lb/sec/ft

c = specific heat of fluid, assumed constant, 0.24 Btu/lb/F

$$\frac{c\mu}{k} = \text{Prandtl number}$$

$$\frac{VD\rho}{\mu} = \text{Reynold's number}$$

The properties of air were evaluated at the mean duct air temperature. The values of thermal conductivity were obtained from Gas Tables[4] by Keenan and Kaye. Over the range of temperatures from 32 to 122 F, the Prandtl number varied from 0.712 to 0.701 and an average value of 0.706 was used throughout the calculations. The inside surface coefficients of heat transfer were evaluated for duct air velocities from 400 to 1200 fpm in increments of 200 fpm, and mean duct air temperatures of 50 to 70 F in increments of 5 F for 4, 5, 6, 7 and 8-in. diam ducts.

The outside surface coefficient of heat transfer due to natural convection was determined by the equation for natural convection found in most heat transfer texts:[3]

$$h_c = 0.53 \frac{k}{D} \left[\frac{D^3 \beta \rho^2 g (t_A - t_W)}{\mu^2}\right]^{0.25} \left[\frac{c \mu}{k}\right]^{0.25} \quad (3)$$

where β = temperature function, reciprocal of absolute temperature, 1/(deg Rankine)

g = gravitational acceleration, 32.16 ft/sec²

For the determination of the coefficient of natural convection, the film temperature (the temperature of the thin stagnant layer of air adjacent to the surface) was assumed equal to the average of the ambient air and duct surface temperatures; the properties of the air film, thermal conductivity, density, dynamic viscosity and the temperature function, were evaluated at the film temperature. The coefficients were determined for ambient temperatures of 75, 100, 125 and 150 F and duct surface temperatures of 55 to 100 F in 5 F increments.

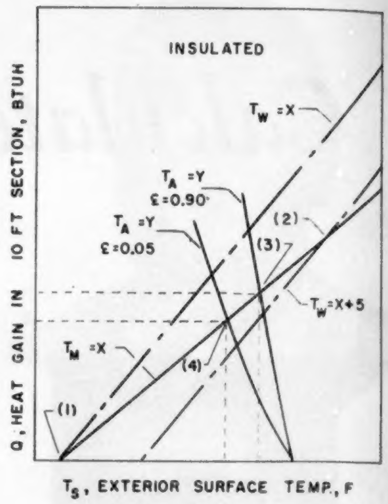


Fig. 2 Graphical solution of equation for heat transfer to air flowing in insulated ducts

The outside surface coefficient of radiant heat transfer was evaluated by the Stefan-Boltzmann[3] equation divided by the difference in ambient and duct surface temperatures, assuming a configuration factor of unity for a small duct located in a relatively large enclosure:

$$h_r = \frac{\sigma \varepsilon (T_A^4 - T_W^4)}{(T_A - T_W)} \quad (4)$$

where

σ = Stefan-Boltzmann constant, 0.173×10^{-8} Btu/hr/sq ft/F⁴

ε = surface emissivity of duct

T_A, T_W = ambient temperature and duct surface temperature, deg R

Equations (1) through (4) apply to any thin wall duct. For the purpose of this analysis, only gray oxidized zinc surfaces with a surface emissivity ε = 0.25 were considered. The ducts installed in the Residence were also of galvanized iron. Radiation coefficients were determined for the same range of ambient and duct surface temperatures as the natural convection coefficients.

After the coefficients of heat transfer were determined, the

Table I Range of Variables in Analysis of Heat Gain to Ducts

Variable	Range
Duct Diameter, in.	4, 5, 6, 7, 8
Duct Air Temperature, F	50, 55, 60, 65, 70
Duct Air Velocity, fpm	400, 600, 800, 1000, 1200
Ambient Temperature, F	75, 100, 125, 150
Insulation Thickness, in.	0, 1, 2
Vapor Barrier Emissivity	0.25 for uninsulated 0.05 and 0.90 for insulated

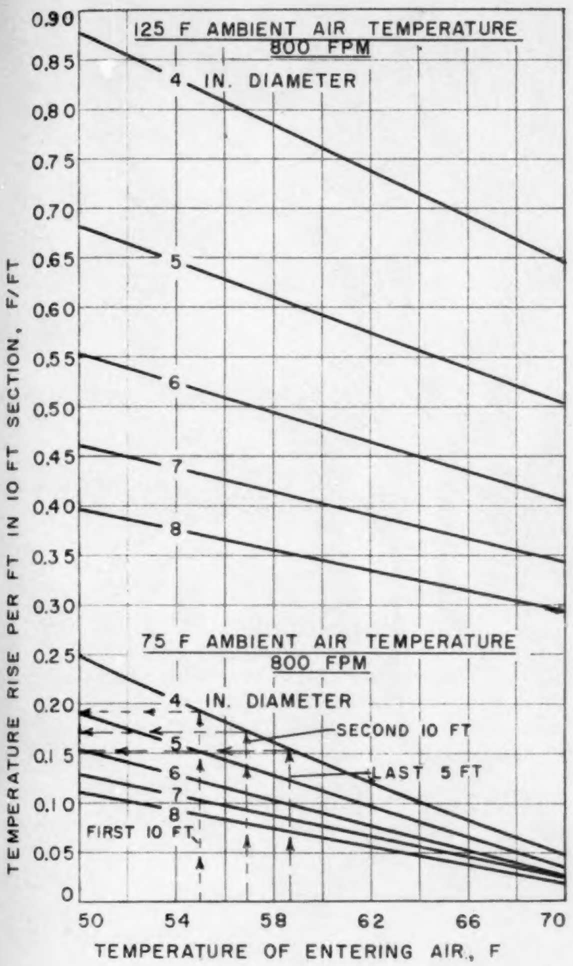


Fig. 3 Temperature rise in uninsulated ducts

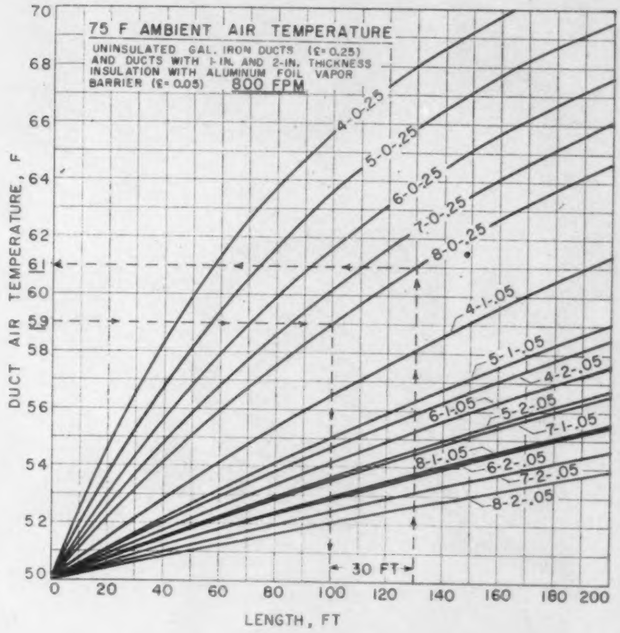


Fig. 4 Temperature-length curves for uninsulated ducts and insulated ducts with aluminum foil vapor barriers at 75 F ambient air temperature

graphical method illustrated in Fig. 1 was used to solve Equation (1) for the heat transfer rate and duct surface temperature. In Fig. 1 each side of Equation (1) is plotted as a function of the duct surface temperature, t_W. The left-hand side of Equation (1) represents the heat transfer through the inside surface. It is represented by a line designated $t_M = x$. For a constant duct air temperature, the heat transfer increases almost linearly with duct surface temperature and is zero for $t_M = t_W$. The heat transfer to the outside surface of the duct at a constant ambient temperature, $t_A = y$, is shown. As the duct surface temperature, t_W, increases, the temperature difference decreases; therefore, the heat transfer would decrease to zero at $t_A = t_W$.

For a specified condition of duct air velocity, duct air temperature and ambient temperature, the intersection (1) of the two curves provides a solution of Equation (1). The duct surface temperature and the heat transfer rate are obtained directly from the coordinates.

The temperature rise in a 10-ft length of duct was determined from the equation:

$$\Delta t = \frac{q}{60\,V\,A\,\rho\,c} \qquad (5)$$

where

Δt = temperature rise of air, F/10 lineal ft

60 = factor to convert velocity from ft/min to ft/hr

A = cross-sectional area of duct, sq ft

The duct surface temperature determines whether condensation will occur. Condensation of vapor will occur if the duct surface temperature is below the dew point of the ambient air. The dew point is a function of the ambient air dry-bulb temperature and relative humidity.

The mean duct air temperature, t_M, represents the tempera-

Table II Temperature Rise in 10-ft Sections of Insulated Ducts, F/ft
75 F Ambient Air

Entering Air Temperature, F	4-in. Diam.				5-in. Diam.				6-in. Diam.				7-in. Diam.				8-in. Diam.			
Vapor Barrier Surface Emissivity	0.05		0.90		0.05		0.90		0.05		0.90		0.05		0.90		0.05		0.90	
Insulation Thickness, in.	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
50 F	.07	.05	.09	.06	.06	.04	.07	.04	.05	.03	.05	.03	.04	.03	.05	.03	.03	.02	.04	.02
55 F	.06	.04	.07	.05	.04	.03	.05	.04	.04	.02	.04	.03	.03	.02	.04	.02	.03	.02	.03	.02
60 F	.05	.03	.05	.03	.03	.02	.04	.03	.03	.02	.03	.02	.02	.02	.03	.02	.02	.01	.02	.01
65 F	.03	.02	.04	.02	.02	.02	.03	.02	.02	.01	.02	.01	.02	.01	.02	.01	.01	.01	.02	.01
70 F	.02	.01	.02	.01	.01	.01	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01

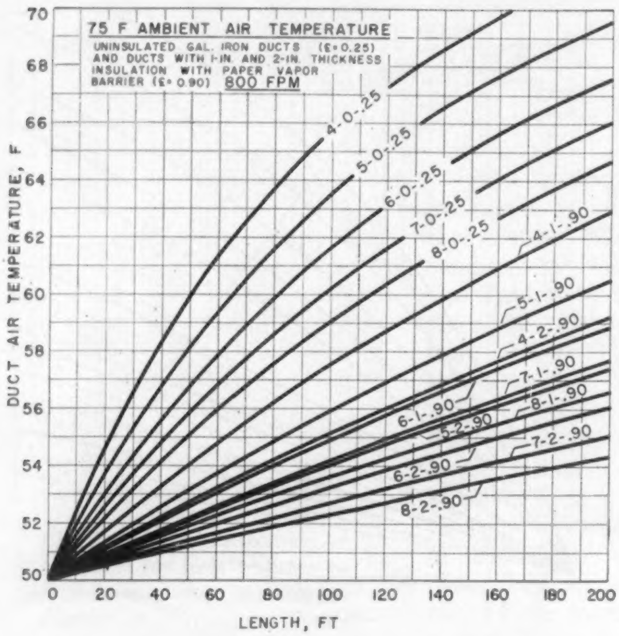


Fig. 5 Temperature-length curves for uninsulated ducts and insulated ducts with paper vapor barriers at 75 F ambient temperature

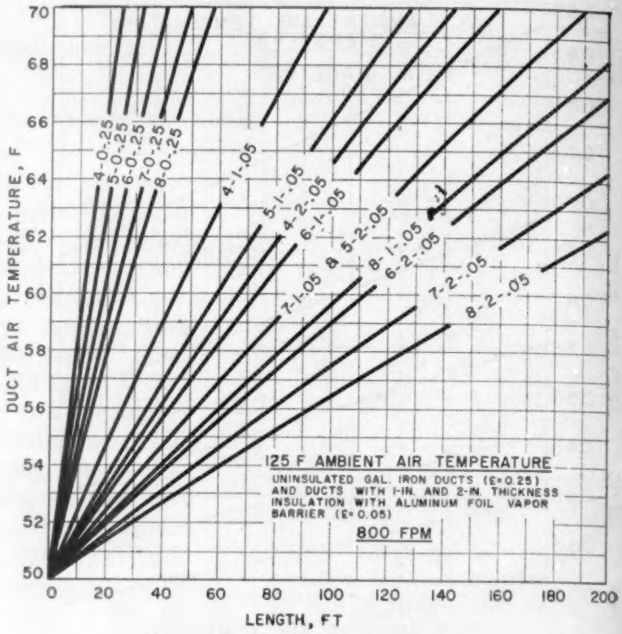


Fig. 6 Temperature-length curves for uninsulated ducts and insulated ducts covered with aluminum foil vapor barrier at 125 F ambient air temperature

ture at the mid-length of a 10-ft section of duct. The entering air temperature is obtained by subtracting one-half Δt from the mean temperature:

$$t_1 = t_M - \frac{\Delta t}{2} \qquad (6)$$

where t_1 = duct air temperature at the entrance of the 10-ft section. The temperature rise was plotted as a function of entering temperature for the various duct air velocities and ambient temperatures. These graphs are discussed in a later section.

Insulated Ducts – The analysis for insulated ducts is similar to the analysis for uninsulated ducts except that the resistance to heat flow imposed by the insulation must be considered. The heat transfer through the inside surface of the duct due to forced convection is the same as for uninsulated ducts. The heat transfer to the outer surface by natural convection and radiation is the same as for uninsulated ducts, except that the outside surface temperature, t_S, is substituted for the duct surface temperature, t_W, and the outside surface area, A_S, is substituted for the duct surface area, A.

The heat transfer through the insulation is given by the conduction equation:

$$q = C\, A_M\, (t_s - t_w) \qquad (7)$$

where

C = thermal conductance of the insulation, Btu/hr/sq ft/F

A_M = log mean area of insulation, $\dfrac{A_s - A_w}{\ln \dfrac{A_s}{A_w}}$, sq ft

Setting the heat transfer through each resistance equal:

$$q = h_i\, A_w\, (t_w - t_M) = C\, A_M\, (t_s - t_w) = (h_c + h_r)\, A_s\, (t_A - t_s) \qquad (8)$$

The inside surface coefficient of heat transfer by forced convection and the heat transfer rate were the same as evaluated for uninsulated ducts.

The coefficient of natural convection was calculated by a procedure identical with that for the coefficient for uninsulated ducts, except that the diameter used in Equation (3) was the outer diameter of the insulation. The surface temperature was t_S instead of t_W.

The radiation coefficient was also calculated similarly to the coefficient for uninsulated ducts. Calculations were made for two types of vapor barriers, aluminum foil and duplex paper. An emis-

Table III Temperature Rise in 10-ft Sections of Insulated Ducts, F/ft
125 F Ambient Air

Entering Air Temperature, F	4-in. Diam.				5-in. Diam.				6-in. Diam.				7-in. Diam.				8-in. Diam.			
Emissivity	0.05		0.90		0.05		0.90		0.05		0.90		0.05		0.90		0.05		0.90	
Insulation Thickness, in.	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
50 F	.23	.16	.26	.17	.18	.12	.21	.13	.14	.10	.17	.10	.12	.08	.14	.09	.10	.07	.12	.07
55 F	.22	.15	.25	.16	.17	.11	.19	.12	.13	.09	.16	.10	.11	.07	.13	.08	.10	.06	.11	.07
60 F	.21	.14	.24	.15	.16	.11	.18	.12	.13	.08	.15	.09	.11	.07	.12	.08	.09	.06	.11	.07
65 F	.19	.13	.22	.14	.15	.10	.17	.11	.12	.08	.14	.09	.10	.06	.12	.07	.08	.05	.10	.06
70 F	.18	.12	.21	.13	.13	.09	.16	.10	.11	.07	.13	.08	.09	.06	.11	.07	.08	.05	.09	.06

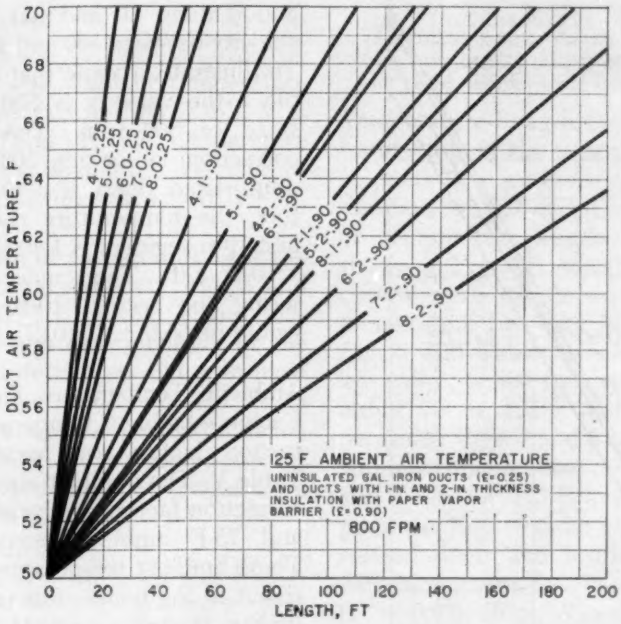


Fig. 7 Temperature-length curves for uninsulated and insulated ducts covered with paper vapor barriers at 125 F ambient air temperature

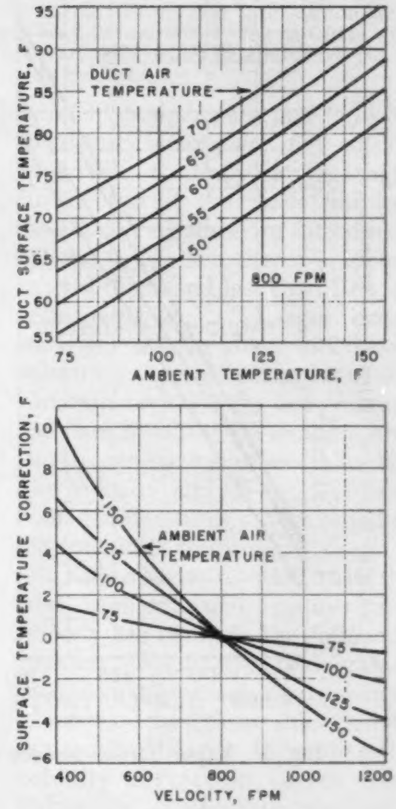


Fig. 8 Surface temperature of uninsulated ducts

sivity of 0.05 was assumed for aluminum foil and an emissivity of 0.90 was assumed for duplex paper, which consisted of two layers of Kraft paper bonded together with a thin layer of asphalt. The conductivity of the insulation was assumed to be 0.27 Btu/hr/sq ft/F/in. of thickness, which gave conductance of 0.27 Btu/hr/sq ft/F for 1-in. thick insulation and 0.135 Btu/hr/sq ft/F for 2-in. thick insulation. Calculations of the heat transfer rate through the insulation were made for both thicknesses of insulation, for duct surface temperatures from 55 to 75 F in 5 F increments and outside surface temperatures from 55 to 150 F in increments of 5 F.

The solution of the heat transfer Equation (8) was solved graphically as indicated in Fig. 2. In this case, the heat transfer was plotted as a function of the outside surface temperature, t_S.

The equation of heat transfer through the insulation yields lines of constant duct wall temperature represented by the lines $t_W = x$ and $t_W = x + 5$. The heat transfer, q, is zero when $t_W = t_S$ and increases linearly as t_S increases, for a constant duct surface temperature. For a constant outside surface temperature the heat transfer rate decreases as the duct surface temperature increases, therefore, the line for $t_W = x + 5$ is below the line for $t_W = x$.

The heat transfer to the outer insulation surface is represented by the two lines designated $t_A = y$. The upper line is for the aluminum foil vapor barrier (emissivity = 0.05) and the lower line is for the duplex paper vapor barrier (emissivity = 0.90). The effectiveness of the lower emissivity vapor barrier in reducing the heat transfer rate and temperature rise is apparent.

The heat transfer through the inside film is dependent upon the mean duct air temperature and the duct surface temperature. If $t_M = t_W = x$, for example, the heat transfer rate is zero as represented by intersection (1) on Fig. 2. If $t_W = x + 5$ and $t_M = x$, the temperature potential is 5 F and the heat transfer may be calculated for this condition; the value is represented by intersection (2) located on the $t_W = x + 5$ line. The intersection of the line of constant mean duct air temperature, t_M, with the line of constant ambient temperature, t_A, for either surface emissivity, intersection (3) or (4), provides a solution of Equation (8). The heat transfer rate and the outer surface temperature are obtained directly from the coordinates. The temperature rise and the entering temperature were determined as for uninsulated ducts, and the temperature rise was plotted as a function of entering air temperature for the various combinations.

RESULTS

Curves of temperature rise as related to entering temperature were plotted for all combinations of duct diameter, insulation thickness, duct air velocity, vapor barrier emissivity and ambient temperatures. For convenient reference the ranges of these items are listed in Table I.

Temperature Rise Curves — These, as related to entering temperature for 800 fpm velocity and 75 and 125 F ambient temperatures, are presented in Fig. 3 and Tables II

Table IV Velocity Correction Factors

Velocity, fpm	400	500	600	700	800	900	1000	1100	1200
Uninsulated Duct	1.60	1.40	1.23	1.10	1.00	0.92	0.85	0.79	0.74
Insulated Duct	1.89	1.57	1.31	1.13	1.00	0.90	0.81	0.74	0.68

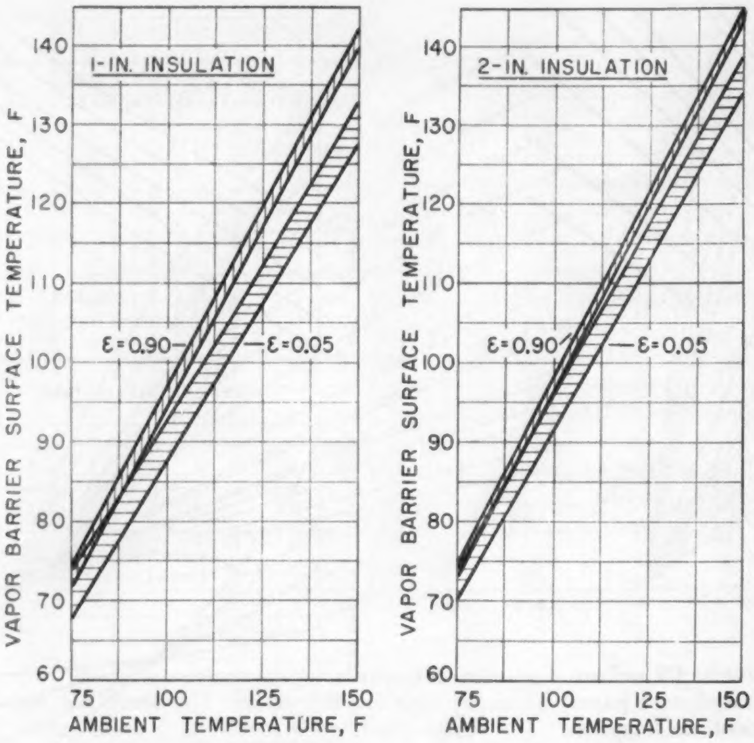


Fig. 9 Vapor barrier surface temperature of insulated ducts

and III for all duct diameters. Fig. 3 is for uninsulated ducts at 75 and 125 F ambient temperature. Table II is for 75 F ambient air and ducts with 1 and 2-in. insulation with vapor barrier surface emissivities of 0.05 and 0.90. Table III is similar to Table II but is for 125 F ambient air. The temperature rise data obtained from the figure and tables show temperature rise per lineal ft in a 10-ft section. If the temperature rise in a duct longer than 10-ft is to be determined the duct must be divided into 10-ft segments. The following example, illustrated in Fig. 3, shows the procedure.

Example 1. A 4-in. diam uninsulated duct is located in a basement where the ambient temperature is 75 F. The duct is 25 ft long. The air temperature at the entrance is 55 F and the air velocity is 800 fpm. Determine the overall air temperature rise and the exit temperature.

Solution: With the entering air temperature of 55 F, Fig. 3 indicates a temperature rise of 0.19 F/ft in the first 10-ft section. Therefore, the air temperature leaving the first 10-ft section is 55.0 + 10 (0.19) = 56.9 F. This is also the entering air temperature for the second 10-ft section. From Fig. 3 the temperature rise in the second 10-ft section is 0.17 F/ft which results in a leaving temperature of 56.9 + 10 (0.17) = 58.6 F. The entering air temperature for the last five ft of duct is also 58.6 F and the temperature rise in this section is 0.15 F/ft. The final temperature is 58.6 F + 5 (0.15) = 59.4 F. The overall air temperature rise is 59.4 — 55.0 = 4.4 F.

Tables II and III permit the determination of temperature rise information for air flowing in insulated ducts with two vapor barrier surface emissivities and exposed to two ambient air temperatures. The temperature rise for unlisted entering air temperatures between 55 and 70 F may be determined by interpolation.

Velocity Correction Factors—These, based on a velocity of 800 fpm, are presented in Table IV. Information is listed for both insulated and uninsulated ducts. The factors were determined by analyzing data for all combinations of ambient temperature, diameter, insulation and velocity. The velocity correction factors are, for all practical purposes, independent of ambient temperature and duct diameter. The maximum deviation from the values listed in Table IV was 3% and the average deviation was 2%. The velocity correction factors for insulated ducts increased slightly with insulation thickness, but the maximum deviation from the values presented in Table IV was only 3.5% and the average deviation was 2%. The velocity correction factors permit utilization of the temperature rise data presented in Fig. 3 and Tables II and III for any velocity between 400 and 1200 fpm. To illustrate, assume that in Example 1 the velocity is 500 fpm instead of 800 fpm. The velocity correction factor for 500 fpm in uninsulated ducts is 1.40. Therefore, the temperature rise in the first 10-ft segment is 1.40 times 0.19 = 0.27 F/ft. The temperature entering the second 10-ft segment would be 55.0 + 10 (0.27) = 57.7 F.

Ambient Temperature Correction Factors—Ambient temperature correction factors are presented in Table V. The ambient temperature correction factors are based on 125 and 75 F ambient temperatures. These ambient temperatures correspond to the temperature rise data in Fig. 3 and Tables II and III. The ambient temperature correction factors are independent of velocity and diameter. They are dependent upon entering temperature and the amount of duct insulation. Presentation of the data as a function of ambient temperature would require a separate curve for each entering air temperature. However, it was found that the ratio

$$\left[\frac{\text{ambient temperature — entering temperature}}{\text{base temperature — entering temperature}}\right]$$

provided an index of the ambient temperature correction factors, and left the amount of insulation as the only remaining variable influencing the factors. Therefore, the ambient temperature correction factors are presented as a function of the ratio given above with separate values listed for uninsulated and insulated ducts.

The ambient temperature correction factors permit utilization of the temperature rise data presented in Fig. 3, and Tables II and III for any ambient temperature between 75 and 150 F. If the ambient temperature is between 75 and 100 F the correction factors are based on the 75 F temperature rise data. If the ambient temperature is between 100 and 150 F the correction factors are based on the 125 F data. To illustrate, assume that in Example 1 the ambient temperature is 85 F instead of 75 F. The correction is based on the 75 F data. The

ratio $\frac{t_A - t_i}{75 - t_i}$ is equal to $\frac{85 - 55}{75 - 55}$ $= 1.5$. The ambient temperature correction factor from Table V is 1.63. Therefore, the temperature rise in the first 10-ft segment of duct is 1.63 times 0.19 = 0.31 F/ft.

Utilization of Curves and Tables – The data presented in Fig. 3 and Tables II, III, IV and V are sufficient for the determination of the temperature rise occurring in most applications. The solution of a typical problem is presented below to illustrate the combined use of velocity and ambient temperature correction factors.

Example 2. A 6-in. diam duct insulated with 1-in. glass fiber insulation and covered with a paper vapor barrier (emissivity = 0.90) is located in an attic space where the ambient temperature is 140 F. The duct is 18 ft long. The air temperature at the entrance to the duct is 55 F and the air velocity is 1000 fpm. Determine the total temperature rise and the exit temperature.

Solution. The velocity correction factor from Table IV is 0.81. From Table V the ambient temperature correction factor for a ratio $\frac{t_A - t_i}{125 - t_i}$ $= \frac{135 - 55}{125 - 55} = 1.14$ by interpolation is 1.14. From Table III for 800 fpm velocity and 125 F ambient temperature, the temperature rise in the first 10-ft segment is 0.16 F/ft. Applying the correction factors and multiplying by 10 ft, the temperature rise in the first 10 ft is (0.81) (1.14) (10) (0.16) = 1.47 or 1.5 F. The temperature entering the 8-ft segment is 56.5 F. The velocity correction factor is the same, 0.81. The new ratio must be calculated to obtain the ambient temperature correction factor:

$$\frac{135 - 56.5}{125 - 56.5} = 1.15$$

and the ambient temperature correction obtained from Table V is by interpolation, 1.15. For 800 fpm velocity and a 125 F ambient temperature, the rise in the last segment is 0.15 F/ft. Applying the correction factors and multiplying by 8 ft, the temperature rise in the last 8 ft of the duct is (0.81) (1.15) (8) (0.15) = 1.1 F. The exit temperature is 56.5 + 1.1 = 57.6 F and the total temperature rise is 2.6 F.

Temperature-Length Curves – Determination of the temperature rise in ducts is more convenient when the data are presented in the form of temperature-length curves as shown in Figs. 4 through 7. These curves were developed from the temperature rise data presented in Fig. 3 and Tables II and III and are valid for 800 fpm velocity and either 75 or 125 F ambient temperature. Figs. 4 and 5 are for 75 F ambient temperature and Figs. 6 and 7 are for 125 F ambient temperature. Figs. 4 and 6 are for uninsulated ducts and insulated ducts with aluminum foil vapor barrier ($\varepsilon = 0.05$). Figs. 5 and 7 repeat the data for uninsulated ducts and contain data for insulated ducts with paper vapor barrier ($\varepsilon = 0.90$). The duct diameter, insulation thickness and exterior surface emissivity is indicated for each curve. For example, 8-1-.05 indicates an 8-in. diam duct with 1-in. insulation and an aluminum foil vapor barrier (emissivity = 0.05). The emissivity of a paper vapor barrier is 0.90 and the surface emissivity of a galvanized iron duct is 0.25. The following example, illustrated in Fig. 4, shows how the temperature-length curves may be utilized.

Example 3. Assume that 59 F air enters an 8-in. diam galvanized iron duct which is uninsulated and 30 ft in length. The ambient air temperature is 75 F.

The arrows on Fig. 4 indicate the use of the curves to determine the final temperature of air leaving the duct. Enter the chart on the ordinate at 59 F (entering temperature). Proceed horizontally to the duct specifications curve (8-0-.25 curve for this example). From the intersection with the curve proceed downward to the length scale on the abscissa (100 ft in this case). Add the length of the duct to the intersected length (100 + 30 = 130 ft). Proceed upward on the 130 ft length line and again intersect the 8-0-.25 curve. From this intersection proceed to the left to the ordinate and read the leaving temperature (61 F in this case).

Ambient temperature and velocity correction factors are not strictly applicable to temperature-length curves, but if the ducts are less than 50 ft long the error introduced will be small; less than 5% for insulated ducts and less than 20% for uninsulated ducts. Larger errors occur for smaller ducts and lower velocities. Specific examples of the variation between the temperature rise data obtained by temperature-length curves for other than 800 fpm velocity and 75 to 125 F ambient temperatures are included in the following section.

Adjustments to other than the base ambient temperatures and velocity are made in the following manner: Obtain the temperature rise from the temperature-length curve for the given duct length as described above. Determine the velocity correction factor from Table IV. Calculate the ratio $\frac{t_A - t_i}{\text{base temp} - t_i}$ and obtain the ambient temperature correction factor from Table V. Multiply the temperature rise obtained from the temperature-distance curve by the velocity and ambient temperature correction factors. The temperature rise obtained by this method will be sufficiently accurate for all but the most precise designs.

Comparison of Measured and Calculated Temperature Rise – Table VI contains a comparison of the measured temperature rise with the calculated temperature rise obtained from both the entering temperature-temperature rise curves and the temperature-length curves. The upper part of Table VI contains data obtained during the 1954 cooling investigation in Research Residence 2. The duct system, which was located in the basement, consisted of extended plenums and 4-in. diam branch ducts. Only the temperature rise in the branch duct was considered. The lower part of Table VI contains data obtained during the 1957 cooling investigation in Research Residence 2.

The duct system consisted of a central plenum and individual branch ducts to each ceiling diffuser. The calculated data were corrected to the attic ambient tem-

Table V Ambient Temperature Correction Factors

100 to 150 F Ambient Range									
$\frac{T_a - T_i}{125 - T_i}$	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
Uninsulated Duct	0.56	0.66	0.78	0.89	1.00	1.12	1.23	1.35	1.46
Insulated Duct	0.59	0.69	0.79	0.90	1.00	1.10	1.20	1.31	1.41

75 to 100 F Ambient Range									
$\frac{T_a - T_i}{75 - T_i}$	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Uninsulated Duct	1.63	2.25	2.90	3.50	4.15	4.80	5.45	6.10	6.80
Insulated Duct	1.50	2.00	2.50	3.05	3.55	4.05	4.60	5.10	5.60

Table VI Comparison of Measured and Calculated Temperature Rise in Ducts

Location	Ambient Air Temp, F	Duct Diam, in.	Surface Emissivity	Length, ft	Vel., fpm	Entering Air Temp, F	Measured Temp Rise, F	Calculated Temp Rise From Ent Temp-Temp Rise Curves F	Calculated Temp Rise From Ent Temp-Temp Rise Curves Deviation, F	Calculated Temp Rise From Temp-Dist Curves F	Calculated Temp Rise From Temp-Dist Curves Deviation, F
		4	0.25	16	1060	58.9	2.8	2.81	0.01	2.84	0.04
		4	0.25	16	1040	59.6	3.5	2.85	0.65	2.88	0.62
		4	0.25	16	410	62.3	3.6	4.33	0.73	4.18	0.58
Basement	78.5	4	0.25	11	620	61.6	2.0	2.45	0.45	2.51	0.51
		4	0.25	4	720	59.6	0.4	0.82	0.42	0.83	0.43
		4	0.25	11	340	62.0	4.3	*	*	*	*
		4	0.25	7	870	56.8	1.6	1.54	0.06	1.62	0.02
		4	0.25	3	1100	58.5	0.3	0.47	0.17	0.57	0.27
		7	0.05	10	546	58.5	1.1	0.93	0.17	0.93	0.17
		7	0.90	8	669	58.7	0.9	0.68	0.22	0.68	0.22
		7	0.05	15	501	58.5	1.8	1.51	0.29	1.51	0.29
Attic	120.0	7	0.90	17	484	58.7	2.5	1.85	0.65	1.97	0.53
		6	0.90	4½	257	59.2	0.4	*	*	*	*
		6	0.05	11	640	58.2	1.4	1.07	0.33	1.12	0.28
		5	0.90	13	278	58.5	5.5	*	*	*	*

* The duct air velocity was below the range covered in the calculations.

perature and the velocity in each duct. The maximum deviation between the measured data and the calculated data was 0.73 F. The average deviation was 0.33 F. and the deviation was almost the same, regardless of which method was used in the calculations.

The maximum deviation between the temperature rise calculated by the entering temperature-temperature rise curves, and calculated by the temperature-length curves was 6.5%. The duct air temperature measurements were accurate within ±0.3 F so that an error of 0.6 F could occur, which is only slightly less than the maximum deviation. Three other possible sources of error were:

1. Duct heat transfer measured was not absolutely steady-state.
2. Basement and attic air temperatures were not necessarily uniform throughout the spaces.
3. Mean radiant temperature was not necessarily equal to the ambient air temperature

The basement air temperature was relatively constant and the compressor had been operating several hours prior to the period of the study so that the heat transfer to the ducts located in the basement was approximately steady-state. For the attic ducts, the data were obtained at 3.00 pm when the attic temperature was 120 F. The maximum attic air temperature, 123 F, occurred at 1:45 pm so that the heat transfer rate was influenced to some extent by the maximum temperature. The average surface temperature, which is an index of the mean radiant temperature, was 122 F when the attic air temperature was 120 F. The calculated temperature rise data were sufficiently accurate for design purposes.

Condensation on Duct Surfaces – The data presented in the preceding sections are based upon the assumption that condensation does not occur on the duct or insulation surfaces. This will be true if the exposed surface temperature is above the dew point of the ambient air. Figs. 8 and 9 show the duct surface temperature for uninsulated ducts and vapor barrier surface temperature for insulated ducts. The surface temperatures are independent of duct diameter.

For uninsulated ducts, the surface temperature is a function of the duct air temperature, ambient temperature and duct air velocity. The surface temperatures of uninsulated ducts exposed to ambient temperature from 75 to 150 F are shown in the upper part of Fig. 8 for a duct air velocity of 800 fpm with duct air temperature as a parameter. The surface temperatures range from 56 to 94 F. For duct air velocities other than 800 fpm the surface temperature must be adjusted by the correction indicated in the lower part of Fig. 8. The surface temperature correction varies from 10.6 to –5.7 F depending upon the velocity and ambient temperature.

The vapor barrier surface temperatures for insulated ducts are shown in Fig. 9. The surface temperature was practically independent of duct air temperature and velocity within the range investigated. It was principally dependent upon ambient temperature, surface emissivity and insulation thickness. The surface temperatures are shown as a function of ambient temperature with bands for each vapor barrier emissivity encompassing all variations due to duct air temperature and velocity. The lower emissivity, in conjunction with reducing the temperature rise in ducts, causes a lower surface temperature. The lower part of the bands are for lower duct air temperature and higher velocities. As stated earlier, condensation will occur if the exposed surface temperature is equal to or less than the dew point of the ambient air.

ACKNOWLEDGMENTS

This paper reports one phase of a comprehensive investigation conducted in Warm Air Heating Research Residence No. 2 under the terms of a cooperative agreement between the National Warm Air Heating and Air Conditioning Association and the Engineering Experiment Station of the University of Illinois. These results will ultimately comprise part of a bulletin of the Engineering Experiment Station.

Acknowledgment is made to the manufacturers who cooperated by furnishing equipment used in the investigation.

REFERENCES

1. Gilkey, H. T., D. R. Bahnfleth, and R. W. Roose, "Cooling a Small Residence with a Two-Horsepower Mechanical Condensing Unit." ASHVE TRANSACTIONS, Vol. 59, New York, 1953.
2. Kratz, A. P., S. Konzo, and R. B. Engdahl, "Temperature Drop in Ducts for Forced-Air Heating Systems." University of Illinois Engineering Experiment Station Bulletin 351, 1944.
3. McAdams, William H., Heat Transmission, McGraw-Hill Book Company, Inc., New York, Third Edition, 1954.
4. Keenan, Joseph H. and Joseph Kaye, Gas Tables, John Wiley and Sons, Inc., New York, 1948.

Humidity-Control in Residential Air Conditioning Systems

It has long been recognized that residential air conditioning equipment, properly sized and installed, will do an excellent job of maintaining comfort conditions for the maximum cooling load for which it has been designed. However, in most parts of the country, conventional air conditioning units solve only part of the problem of full-time comfort control. Relatively useless on cool, humid days or evenings, because of inability to dry or dehumidify the air, the equipment failed to maintain comfort conditions without cooling further. In most parts of the country humidity control is required from two to four times as many hours as straight cooling. Recognizing these facts, it was evident that residential air conditioning equipment, capable of accomplishing "round-the-clock" comfort control, would assist greatly in developing the vast market potential that exists for summer air conditioning equipment.

A market and product feasibility study was instituted to establish the advisability of developing, manufacturing and marketing a unit which would accomplish both sensible temperature control as well as humidity control whenever it is required. Our study convinced us that a sizable potential market existed throughout the country for a unit which would meet these requirements. We recognized that

R. L. SIGNORELLI

the general consumer was not yet sophisticated enough about residential air conditioning to understand immediately the additional benefits which could be derived from such a unit over those offered by the conventional unit, but we did feel that a marketing, merchandising and consumer education program could be developed which would generate sales to the extent that they would justify the expenditures required for the development and marketing of such a unit.

We were further convinced that we could anticipate considerable marketing assistance from the electrical utilities throughout the country. Humidity control air conditioning equipment would provide the utilities with as much as two to four times the hours of unit operation, providing higher load factors and increased revenue, without requiring increased generating capacity.

Table I* indicates the number of days in each of the geographical areas with mean temperatures above 75 F. These are the approximate number of days annually when conventional air conditioning, with its by-product, dehumidification, has some use in an average home. However, it is recognized that it will be deficient in moisture removal on most evenings. Here column 2 shows the number of days in each of the listed geographical areas with mean temperatures above 80 F. In the majority of climate areas, conventional air conditioning will do a fair job around the clock on the number of days that have a mean temperature above 80 F. A number of studies have established that generally there is a rise in relative humidity between midnight and 8:00 a.m. on these days.

Column 3 provides the number of days in each of the geographical areas with dew points above 45 F. Humidity-control air conditioning would be useful and usable 24 hr a day on all of these days when it is desirable to control temperature, humidity or air cleanliness. The geographical areas indicated represent a good cross-section of the entire country and illustrate the tremendous requirement for humidity control, in addition to conventional sensible temperature control as provided by the conventional unit.

From a product standpoint, we developed three approaches for

R. L. Signorelli is Assistant to Vice President of Manufacture, Mueller Climatrol. **This is a somewhat condensed version of "Humidity and Its Control in Residential Air Conditioning Systems" as presented at the Air Conditioning Symposium, ASHRAE Semiannual Meeting, Chicago, February 13-16, 1961.**

*** Based upon data supplied by the Electric Space Heating and Air Conditioning Committee, Edison Electric Institute.**

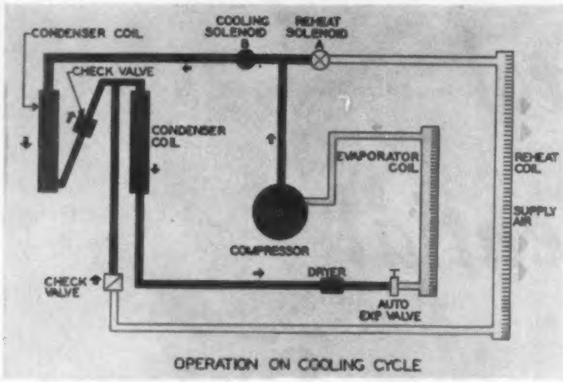


Fig. 1 Operation on the cooling cycle

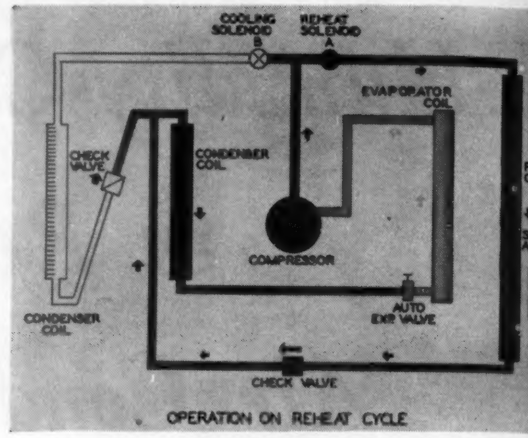


Fig. 2 Operation on the reheat cycle

consideration, which would accomplish the desired results. First, we proposed a single compressor, 3-ton unit, either remote or packaged, to operate as a conventional air conditioning unit under control of a sensible thermostat, or as a dehumidifier under control of the humidistat, using the conventional furnace, firing at reduced input as the reheat device. Practical field application problems did not make this approach desirable.

Second, we sought a two-compressor unit, either packaged or remote, with the first compressor, 3-ton, operating as a standard air conditioning unit and the second compressor, ¾-ton, operating as a standard dehumidifier.

Finally, there was a two-compressor unit, each 2-ton, either packaged or remote, operating as a conventional 2-stage air conditioning unit, with the second stage so arranged that it could also operate as a humidity control unit, utilizing the hot gas reheat principle and operating under control of a humidistat as required. This proposal offered the most desirable approach and a development program was authorized and instituted.

Because of installation problems inherent in the use of a 2-compressor remote condensing unit, further compounded by the use of the hot gas reheat principle, a self-contained unit approach was selected. The use of the dual system approach offered the further advantage of being able to size and circuit one of the two systems to obtain maximum air conditioning capacity, and to operate the second system at a coil temperature of approximately 38 F with air flow regulated so as to achieve the maximum practical latent capacity. Several major design problems related to the reheat principle immediately became obvious.

The use of hot gas as the means of accomplishing reheat, normally required under cool ambient temperatures, presented a problem of adequately balancing the sensible cooling capacity of the system, while minimizing the fall in condensing pressure and temperatures which would be inherent under these operating conditions. Too large a fall in condensing temperature, due to excess condenser surface and low condenser ambient temperatures, would reduce the reheat capacity of the coil and, under certain operating conditions, could result in too low a pressure differential between the high and low sides of the refrigerating systems to handle the required amount of refrigerant through the expansion device.

It was not economically feasible to build into the circuit a means for maintaining the condensing temperature and pressure at some design value. It was then established that on the reheat cycle we would eliminate a portion of our normal condenser from the circuit, so as to maintain a satisfactory condensing temperature with sufficient capacity in the reheat coil to balance the sensible cooling capacity of the system under the desired operating conditions.

As a design basis for operation on the dehumidification cycle, the operating conditions considered most practical would be outdoor conditions in the temperature range of 65 to 75 F with indoor design conditions of 75 F D.B. and 50 per cent humidity. Ideally, it would be most desirable to balance sensible cooling capacities at outdoor temperatures in the 75 to 80 F range and to then have the reheat capacity at outdoor conditions of 65 to 70 F exceed the sensible capacity to some extent, inasmuch as interior heat gain would be ideal under these circumstances. Practical design and marketing consideration, however, did not make this possible. Without incorporating into the system a means for modulating the amount of reheat in order to have reheat capacity substantially exceed sensible cooling effect at outdoor ambient conditions of 70 F or lower, the excess reheat capacity at outdoor temperatures in the 80 to 85 F range would have been so excessive as to have rendered our approach impractical, if system operating cost were to be a significant consideration in the design of the unit.

As a practical compromise, we sought to balance the reheat capacity to sensible capacity at indoor conditions of 75 F D.B. and 50 per cent relative humidity, and outdoor conditions in the 70 F range, so that by the time the reheat capacity exceeded sensible cooling capacity by a significant amount, outdoor conditions will have reached the point, 85 to 90 F. Here sensible cooling will be required the majority of the time, to such an extent that satisfactory dehumidification can be achieved as a by-product of operation as a conventional air conditioning unit.

Table I Summary of Local Weather Data Sheets

	(1) No. of Days With Mean Temp. Above 75 F	(2) No. of Days With Mean Temp. Above 80 F	(3) No. of Days With Dew Point Above 45 F	Average AHE on Days With Dew Point Above 45 F
Binghamton, N. Y.	12	1	104	27
Birmingham, Ala.	89	69	160	47
Canton, Ohio	32	8	123	35
Chicago, Ill.	53	26	139	36
Corpus Christi, Texas (year)	189	133	322	60
Fort Wayne, Ind.	29	4	119	39
Hartford, Conn.	24	6	109	32
Laredo, Texas (year)	210	173	291	37
Los Angeles, Calif.	20	5	114	22
Madison, Wisc.	28	6	113	37
Minneapolis, Minn.	32	5	107	34
Oklahoma City, Okla.	101	74	117	32
Philadelphia, Pa.	48	12	142	37
Phoenix, Ariz.	138	118	105	23
Providence, R. I.	22	5	108	32
Raleigh, N. C.	78	24	148	51
Richmond, Va.	67	32	116	51
Roanoke, Va.	55	28	141	44
St. Louis, Mo.	85	35	135	43
Spokane, Wash.	17	3	41	11
Tampa, Fla. (year)	164	81	337	52
Toledo, Ohio	24	7	111	35

Several methods of system circuitry were developed. Fig. 1 indicates the circuit used when the reheat stage is operating on the air conditioning cycle. Hot discharge gas is routed from the compressor discharge port to a tee fitting, upon which are mounted the cooling and reheat solenoid valves. The hot gas is routed through solenoid valve "B," through the first two rows of the condenser coil, then into a crossover tube, which connects the first two parallel passes of the condenser with the second two parallel passes. Mounted in this crossover tube is a check valve with the flow indicated by the arrow. The refrigerant flows through the balance of the condenser, through a refrigerant drier, the automatic expansion valve, the evaporator coil and back to the compressor through the suction line.

Fig. 2 indicates the circuit used on the reheat cycle. Solenoid valve "B" is de-energized and closed, and solenoid valve "A" is open. The hot gas is then directed first through the single-row reheat coil, which is on the outlet side of the evaporator. The gas flows through the reheat coil and high pressure connector line through a check valve with the flow indicated by the arrow into the last two parallel passes on the outdoor coil. Because of the check valve in the crossover line between the first two passes of the condenser coil and the last two passes, the first two passes of the condenser are eliminated from the refrigerant circuit during the reheat cycle. Conversely, because of the action of the solenoid valves and the check valve in the hot gas connector line, the reheat coil is removed from the refrigerant circuit when the unit is operating on the maximum sensible air conditioning phase.

The key to the success of this circuitry depends on attaining a positive shut-off of that portion of the circuit which is by-passed out of the system during either the reheat or air conditioning phase of operation. Herein lay one of the first problems encountered during the development test phase of the unit. Initially, a modified heat pump reversing valve was utilized to accomplish the switching-in direction of flow of the refrigerant hot gas. It was noted, however, that under prolonged operation on either the reheat or air conditioning cycle, there was a migration of refrigerant into that portion of the circuit which was being by-passed.

Investigation indicated that the small, almost insignificant, amount of internal leakage present in the reversing valve, which would have no effect whatsoever in the straightforward application of the valves for which they were designed, could result ultimately in undercharging the active portion of the refrigerator circuit due to the migration of the refrigerant into the inactive portion. Positive shut-off solenoid valves designed for high-pressure, high-temperature Refrigerant 22 were installed in the tee, and this problem was resolved satisfactorily.

It was determined that we would utilize an automatic expansion valve as the expansion device in the second stage of the unit. Capillary tubes were used in the conventional air conditioning stage. In order to obtain maximum dehumidifying capacity, it was desirable to operate the evaporator coil in the temperature range of 36 to 39 F under all normal operating conditions. The conventional thermostatic expansion valve did not meet this requirement, thereby limiting the choice to either an automatic expansion valve or capillary tube application.

Because of the wide range of condensing temperatures and pressures anticipated in this application, the automatic expansion valve seemed the most satisfactory selection. It had the advantages of maintaining the desired suction pressure under operating conditions of low load conditions, virtually eliminating the possibility of evaporator freeze-up, maximizing capacity under conditions of high internal load and low outside ambient, since it is not as sensitive or responsive capacity-wise to changes in condensing pressure as is the capillary tube, and lastly the refrigerant charge is less critical, limited mainly to avoid floodbacks at low load when the valve is wide open.

Admittedly, under heavy load conditions, this selection resulted in some loss of effective evaporator coil surface, due to the high superheat at the outlet of the evaporative coil because of the fact that the suction pressure is limited by the setting of the valve. ASHRAE capacity tests indicated that the capacity loss was not too significant. During initial tests, a severe vibration was noted at the automatic expansion valve. Subsequent modifications indicated that the vibration was caused by excessive liquid velocity entering the valve, and a change from a ¼-in. liquid line to a ⅜-in. liquid line eliminated the problem.

To attain maximum utilization

of available condenser surtace, evaporator condensate is sprayed onto the condenser surface by means of a centrifuge mounted on the condenser fan shaft. Any condensate not utilized is drained through a drain connection at the base of the unit beneath the condenser coil.

WITH WHAT CONTROLS?

A major problem was the development of a complete control system that would accomplish the desired results. A compact thermostat, incorporating heating, two-stage cooling and humidistat was necessitated. Control requirements dictated that either of the two-stage sensible cooling phases of the controls system had priority and the humidistat operated the second stage of the unit only when sensible temperature conditions were satisfied.

Because of the possibility that either of the two solenoid valves might fail to open properly, a high pressure cut-out was placed in the discharge line between the compressor and the solenoid valve tee. It was decided also to incorporate off-cycle heating in the second stage compressor, due to the adverse operating conditions under which it may be expected to operate. An off-cycle compressor heating circuit was incorporated, in which the run capacitors of the unit are in series with the compressor windings during the off-cycle, thereby impressing a low voltage at all times on the compressor motor windings, keeping them warm enough to eliminate the possibility of refrigerant migration into the compressor during the off-cycle. Low pressure cut-outs were also utilized in both of the refrigerant systems to protect against compressor failure due to loss of refrigerant charge.

To achieve maximum latent cooling capacity in the second-stage system, baffles were utilized in the evaporator air-flow circuit to properly control and reduce the air flow over the evaporator surface of the dehumidification stage so that we could achieve maximum latent heat capacity. Accelerated life tests were conducted on the units in our laboratory with the units operating for two minutes as an air conditioning unit, two minutes as a dehumidification unit and repeating this cycle for a period of approximately three months—24 hr a day.

Maximum cooling capacity of the unit at ASHRAE conditions was 41,540 Btu/hr. At inlet evaporator inlet conditions of 75 F D.B. and 50 per cent condenser air inlet conditions of 70 F D.B., the outlet average air-dry-bulb temperature is 75.25 F and the moisture removed is 5 lb per hr. At indoor conditions of 75 and 50 per cent, outdoor air inlet conditions of 95 F, the outlet average dry bulb temperature is 78 F and the moisture removed is 4.2 lb per hr. At evaporator inlet conditions of 80 – 50 per cent R.H., outdoor temperatures of 75 F, the average outlet air temperature is 81 F and the moisture removed is 5.87 lb per hr. At evaporator inlet conditions at 80 F, 50 per cent outdoor conditions of 95 F, the outlet average D.B. temperature is 84.75 F, and the moisture removed is 5.25 lb per hr. An extreme operating condition is indicated where the evaporator inlet condition is 70 F D.B. and 70 per cent R.H., the outdoor air conditions are 75 F, the outlet average D.B. temperature is 72.5 F and the moisture removed is 6.90 lb per hr. A lighter load condition is indicated where the evaporator air inlet conditions are 70 F D.B. and 50 per cent R.H., the condenser air inlet 75 F, the outlet D.B. temperature is 71 F and the moisture removed is 2.50 lb per hr.

RESULTS

What was our field performance and marketing experience? From a performance standpoint, we are extremely gratified with the results obtained. We have had reports on a number of installations in both residential and commercial applications and the units have operated to the complete satisfaction of the customer. Reports on the residential applications, where the units have been installed, indicate that in almost all cases, the home owner has been completely satisfied with the performance of the unit. It has become evident to us, however, that the consumer must be appraised in advance that the benefits to be derived from such a unit come at the expense of higher operating costs.

From a marketing standpoint, we have thus far been disappointed. Not only is an expanded program directed at informing the customer of the advantages of such a unit required, but the trade has been slow to realize the market potential and sales advantages of such a unit. We are still convinced that our appraisal of the tremendous market potential which exists for such equipment is correct, but we are aware that a substantial educational program must be conducted; first, at the installing contractor level in order to convince him of the sales and marketing advantages of this equipment before the true potential of such equipment can be realized.

NEXT Month——— On the spot news report of the ASHRAE 68th Annual Meeting with interpretative reviews of each of these papers presented at the Technical Sessions.

News of the high lights of the four Symposiums.

Report of activities at business and social sessions.

Pictures of the meeting and its various happenings.

Solubility of Refrigerants

11, 21 and 22 in organic solvents containing a nitrogen atom and in mixtures of liquids

ALLEN THIEME

LYLE F. ALBRIGHT

Absorption cooling cycles use a combination of absorption and stripping steps instead of the mechanical compressor of the vapor compression cycle. Advantages of the absorption cycle include lower operation costs if efficient absorption and stripping steps can be realized. Since the efficiency of these steps is determined largely by the chemical and physical properties of the solvent-refrigerant combination, evaluation of these properties is of importance in the development of an economical absorption cooling cycle.

From a consideration of the absorption cooling cycle, an efficient cycle would be one in which a large amount of refrigerant is evaporated in the generator from a given amount of solution. Such a solvent-refrigerant system would be one in which the refrigerant is soluble in the solvent in large excess of the amount predicted by Raoult's Law.

Using this supposition, Zellhoefer and co-workers[2,3,4,11,12] measured the solubilities of several halogenated methanes in many organic solvents. They found that halogenated methanes which contained a hydrogen atom in the molecule produced excess solubility in organic solvents in many cases. This excess solubility was attributed to "hydrogen bonding," which has since been shown to be essentially an electrostatic attraction between molecules.[7] Other investigators[1,8,9,10] have used this principle to seek a good solvent-refrigerant combination for the absorption cooling cycle. One of the best solvents found to date is the dimethyl ether of tetraethylene glycol. Eiseman[5] calculated coefficients of performance (C.O.P) of this solvent with several refrigerants and found a C.O.P. as high as 0.375.

In this investigation, the solubilities of three fluorochloro methanes were studied in several organic compounds containing a nitrogen atom. In addition, a preliminary attempt was made to evaluate binary mixtures of low volatile organic liquids as solvents.

EQUIPMENT AND OPERATING PROCEDURE

Vapor pressure measurements were made using static methods. The apparatus utilized and the procedure used were essentially the same as those previously reported.[1]

Refrigerants used in this investigation were all commercial grade products.

Most of the solvents were also commercial grade materials.

RESULTS

Solubility data were obtained for a total of sixteen binary and nine

Table I Qualitative Results of Solubility Studies of Binary Mixtures

Solvent	Ref. 11 (CCl_3F)	Ref. 21 ($CHCl_2F$)	Ref. 22 ($CHClF_2$)
Tetraethylene Pentamine	Reacted	Reacted	Reacted
Dimethyl Formamide (DMF)	VLS	VHS	VHS
Diethyl Formamide (DEF)	—	VHS	VHS
Ethyl Formamide	—	LS	—
Dimethyl Aniline	—	HS	—
m-Chloro Aniline	—	LS	—
Aniline	—	LS	—
n-Octyl Amine	—	HS	—
n-Octyl Cyanide	—	HS	—
N-Methyl Morpholine	—	HS	—
Nitrobenzene	—	AS	—

VLS—Very low solubility
LS—Low solubility
AS—Average solubility
HS—High solubility
VHS—Very high solubility

Allen Thieme is with the National Carbon Co.; Lyle F. Albright is Professor, School of Chemical Engineering, Purdue University.
This paper was presented at the ASHRAE 68th Annual Meeting, Denver, Colo., June 26-28, 1961.

ternary systems. Equilibrium pressures for each system were plotted versus the mole fraction of the refrigerant, with temperature as a parameter. Fig. 1 indicates the results for the system of Refrigerant 21 and diethyl formamide (DEF). In all cases, a system that showed either positive or negative deviations from Raoult's Law at one point showed similar deviations over all ranges of temperature and pressure. The qualitative comparison of the solubility results for the binary mixtures are given in Table I and Figs. 2 and 3 give quantitative comparisons for the solubility of Refrigerant 21 in aromatic solvents and in miscellaneous aliphatic solvents, respectively. Hydrogen bonding was found to be an important factor in solubilities of compounds such as those used in this investigation.

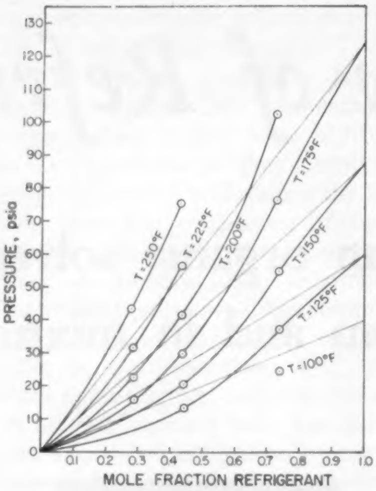


Fig. 1 Solubility of Refrigerant 21 in diethyl formamide

Results for binary mixtures indicate that nitriles (or cyanides) are fairly good solvents for the halogenated methanes. Aromatic primary amines are poor solvents, but tertiary amines containing one aromatic nucleus and two aliphatic groups are good solvents. Aliphatic primary amines are good solvents; however, polyethylene polyamines react with halogenated methanes to form complex mixtures of water-soluble amine salts. Perhaps the aliphatic amine also may have reacted to a small but undetected extent.

The most promising solvents studied in this investigation were the di-N- substituted formamides and the basic solubility data obtained for these systems are shown in Tables II through V. Both diethyl formamide (DEF) and dimethyl formamide (DMF) showed high negative deviation from Raoult's Law with either Refrigerant 21 or 22. On a mole basis, DEF dissolved more refrigerant than DMF; but on a weight basis, DMF was a slightly better solvent. It is of interest to note that the systems DMF-Refrigerant 11 and ethyl formamide – Refrigerant 21 showed positive deviations from Raoult's Law.

Mixtures of two organic liquids also were evaluated as solvents for the halogenated methanes. Nine ternary systems were studied and these are listed in Table VI. All of these ternary systems except DMF – aniline – Refrigerant 21 showed negative deviations from Raoult's Law. It is important to note that all of the pure compounds, except aniline, that were used to form the binary solvents dissolved more Refrigerant 21 than Raoult's Law predicts. Pure aniline showed positive deviations with Refrigerant 21 and, when mixed with DMF, the resulting ternary system approached ideality.

The binary mixtures used as solvents for the refrigerants produced partial pressures of refrigerant above the ternary solution that are approximately a linear function

Table II

Solubility of Refrigerant 21 in N,N-dimethylformamide

Temperature F	Pressure psia	Mole Fraction Refrigerant
100	4.4	.256
	13.2	.514
	28.5	.785
125	7.1	.255
	19.1	.513
	43.2	.785
150	10.8	.254
	29.7	.512
	63.3	.783
175	16.7	.251
	42.4	.511
	88.2	.782
200	23.6	.249
	59.2	.510
225	32.7	.247
	80.7	.508

Table III

Solubility of Refrigerant 22 in N,N-dimethylformamide

Temperature F	Pressure psia	Mole Fraction Refrigerant
100	19.5	.212
	56.0	.483
	96.0	.639
125	28.0	.209
	79.5	.480
	130.0	.627
150	39.0	.205
	111.0	.475
	171.0	.617
175	52.0	.201
	146.0	.470
	216.0	.595
200	67.5	.196
	186.5	.465
	265.5	.577
225	86.0	.189
	234.5	.458
250	107.5	.182
	288.0	.452

Table IV

Solubility of Refrigerant 21 in N,N-diethylformamide

Temperature F	Pressure psia	Mole Fraction Refrigerant
100	24.6	.738
125	13.1	.441
	37.2	.736
150	20.5	.439
	54.9	.733
175	15.8	.288
	29.7	.437
	76.2	.729
200	22.7	.286
	41.2	.434
	102.2	.725
225	31.7	.282
	56.3	.431
250	43.2	.278
	75.2	.427

Table V

Solubility of Refrigerant 22 in N,N-diethylformamide

Temperature F	Pressure psia	Mole Fraction Refrigerant
100	25.5	.324
	61.0	.533
	138.0	.785
125	36.5	.320
	85.5	.530
	188.0	.780
150	52.5	.315
	118.5	.525
	253.0	.773
175	69.5	.310
	157.5	.520
200	89.5	.304
	198.0	.516
225	113.5	.298
	248.0	.510
250	141.5	.289

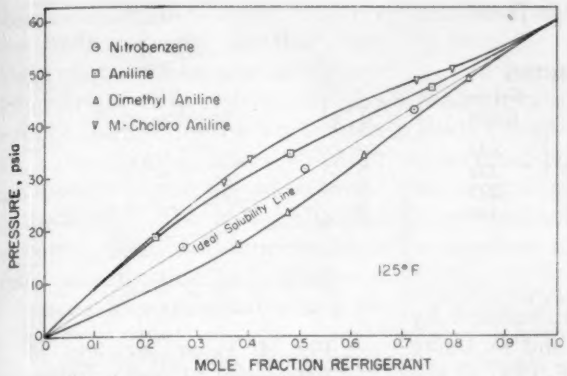


Fig. 2 Solubility of Refrigerant 21 in some closely related solvents at 125 F

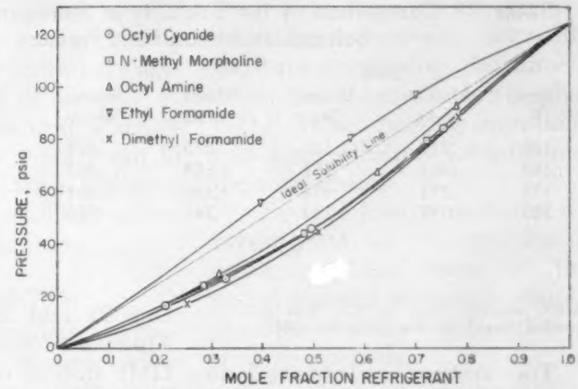


Fig. 3 Solubility of Refrigerant 21 in various solvents at 175 F

of the solvent composition, at constant temperature and mole fraction refrigerant, as shown by Fig. 4. Three different mixtures of the dimethyl ether of tetraethylene glycol (DME-TEG) and DMF were evaluated as solvents in Fig. 4. The approximate straight line relationship between refrigerant partial pressure and solvent composition held over the entire range of refrigerant composition, as can be seen from Fig. 5.

DISCUSSION OF RESULTS

The precision of the data in this investigation is generally within 1.0 psi for pressures below 100 psig; and within 2.0 psi for pressures above 100 psig. The maximum error is estimated to be less than 2.5 psi for pressures up to 100 psig, and less than 5.0 psi for pressures above 100 psig.

A comparison has been made of the solvent capacities of DMF and of DEF with those of DME-TEG, which has been suggested as a good solvent for the halogenated methanes[5,6]. On a mole basis, DME-TEG is best. However, DME-TEG has a molecular weight of 222, whereas the molecular weights of DMF and DEF are 73 and 101, respectively. When the solvents are compared on a weight basis as shown in Table VII and Fig. 6, DMF and DEF are better solvents than DME-TEG.

Eiseman[5] compared the efficiency of solvent-refrigerant combinations by calculating the coefficient of performance (C.O.P), pumping requirements, etc., with DME-TEG as a solvent, and various fluoro-chloro alkanes as refrigerants. Exactly the same step-by-step calculations are made in Table VIII, using different solvents, but two of the same refrigerants. In order to make the calculations in Table VIII, the specific gravities and specific heats of DMF and DEF were needed. The values used and the sources are listed.

DMF, specific gravity = 0.945 from Perry, J. H., "Chemical Engineers' Handbook" 3rd Edition, McGraw-Hill Book Co. (1950).

DEF, specific gravity = 0.908 from Lange, N. A., "Handbook of Chemistry", 8th Edition, Handbook Publishers, Inc. (1952).

DMF, specific heat = 0.5 from "DMF Product Information," Grasselli Chemicals Depts., E. I. duPont de Nemours and Co.

Table VI Qualitative Solubility Results for Ternary Systems

Solvent	Refrigerant	Results
Dimethyl Formamide (DMF) and Triacetin Mole Ratio $\frac{\text{Triacetin}}{\text{DMF}} = 1.07$	21	HS
Dimethyl Ether of Tetraethylene Glycol (DME-TEG) and Triacetin Mole Ratio $\frac{\text{DME-TEG}}{\text{Triacetin}} = 1.03$	21	VHS
DME-TEG and Triacetin Mole Ratio $\frac{\text{Triacetin}}{\text{DME-TEG}} = 1.41$	22	VHS
DMF—Aniline Mole Ratio $\frac{\text{Aniline}}{\text{DMF}} = 0.99$	21	AS
DME-TEG and Tetraethylene Pentamine Mole Ratio $\frac{\text{DME-TEG}}{\text{Amine}} = 0.97$	21	VHS
DME-TEG and DMF Mole Ratio $\frac{\text{DME-TEG}}{\text{DMF}} = 0.82$	22	VHS
DME-TEG and DMF Mole Ratio $\frac{\text{DME-TEG}}{\text{DMF}} = 0.39$	21	VHS
DME-TEG and DMF Mole Ratio $\frac{\text{DME-TEG}}{\text{DMF}} = 1.03$	21	VHS
DME-TEG and DMF Mole Ratio $\frac{\text{DME-TEG}}{\text{DMF}} = 3.50$	21	VHS

Table VII Comparison of the Solubility of Refrigerant 21 in Three Solvents at Atmospheric Pressure

Temp. F	DMF Moles/Mole	DMF Grams/Gram	DEF Moles/Mole	DEF Grams/Gram	DME-TEG Moles/Mole	DME-TEG Grams/Gram
125	.779	1.10	.870	.885	1.35	.625
150	.463	.652	.558	.567	.840	.338
175	.292	.411	.355	.361	.504	.233
200	.191	.269	.261	.266	.322	.149

DEF, specific heat = 0.5, was estimated, based on the value for DMF.

The systems calculated in Table VIII are Refrigerant 21 with DMF and DEF (Columns 3 and 5), and Refrigerant 22 with DMF and DEF (Columns 4 and 6). The results are compared to the systems DME-TEG with Refrigerants 21 and 22 as calculated by Eiseman (Columns 1 and 2). Using DMF instead of DME-TEG as the solvent increases the C.O.P. by about 15%, DEF results in a 1-3% increase in the C.O.P., as compared to DME-TEG.

Although DMF and DEF are good solvents based on solubility

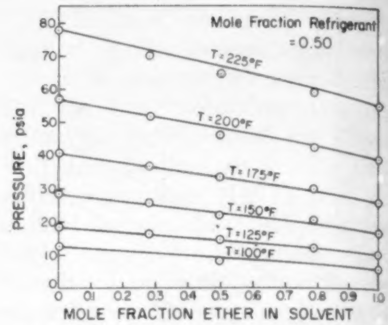


Fig. 4 Vapor pressures of Refrigerant 21 over solutions of dimethyl ether of tetraethylene glycol, dimethyl formamide and Refrigerant 21 as a function of solvent composition

Table VIII Calculation of Performance Characteristics of Solvent—Refrigerant Combinations System

Step	DME-TEG + 21	DME-TEG + 22	DMF + 21	DMF + 22	DEF + 21	DEF + 22
Molecular Weight	102.9	86.5	102.9	86.5	102.9	86.5
Boiling Point, C	+8.9	—40.8	+8.9	—40.8	+8.9	—40.8
Boiling Point, F	+48.1	—41.4	+48.1	—41.4	+48.1	—41.4
1	105.2	87.4	105.2	87.4	105.2	87.4
2	10,820	7,560	10,820	7,560	10,820	7,560
Absorber						
Op. Temp., F	95	95	95	95	95	95
Op. Press, psia	12.3	83.7	12.3	83.7	12.3	83.7
3	0.680	0.748	0.52	0.62	0.57	0.65
4	49.6	53.6	60	66	57	62
5	2.125	2.97	1.08	1.63	1.33	1.86
Generator						
Op. Temp., F	232	232	232	232	232	232
Op. Press., psia	42.9	224.6	42.9	224.6	42.9	224.6
6	0.414	0.516	0.29	0.41	0.34	0.45
7	24.7	29.3	36	45	34	41
8	0.706	1.07	0.41	0.69	0.52	0.82
9	1.419	1.90	0.67	0.94	0.81	1.04
10	42.9	224.6	42.9	224.6	42.9	224.6
11	12.3	83.7	12.3	83.7	12.3	83.7
12	30.6	140.9	30.6	140.9	30.6	140.9
13	15,360	14,364	7,250	7,200	8,760	7,860
14	2.250	2.995	2.250	2.995	2.250	2.995
15	3.425	4.051	2.40	2.67	2.77	3.20
16	4.567	5.401	3.20	3.56	3.70	4.27
17	1.494	2.238	1.80	2.91	1.91	2.97
18	3.744	5.233	4.05	5.91	4.16	5.97
19	8.311	10.634	7.25	9.47	7.86	10.24
20	1.379	1.213	1.379	1.213	1.379	1.213
21	0.325	0.517	0.352	0.584	0.362	0.590
22	0.540	0.639	0.407	0.451	0.488	0.564
23	0.8656	1.156	0.759	1.035	0.850	1.154
24	80.6	190.9	80.6	190.9	80.6	190.9
25	0.0408	0.129	0.0357	0.115	0.0400	0.129
26	0.088	0.279	0.077	0.249	0.087	0.279
27	3.73	11.8	3.28	10.5	3.67	11.8
28	20.9	66.1	18.7	58.9	20.5	66.1
29	0.255	0.298	0.255	0.298	0.255	0.298
30	0.955	1.559	1.03	1.76	1.06	1.78
31	2.041	2.414	1.60	1.78	1.85	2.14
32	2.996	3.973	2.63	3.54	2.91	3.92
33	1.000	1.326	0.88	1.18	0.97	1.31
34	52.2	91.4	62.9	119	66.7	121
35	279.7	330.7	219	244	254	293
36	331.9	422.1	282	365	321	414
37	1.00	1.27	0.85	1.10	0.97	1.25
38	0	27	—15	10	—3	25
39	0	12.8	—0.62	10.7	—0.11	12.8
40	0	40	—15	21	—3	38
41 (C.O.P.)	0.375	0.268	0.44	0.31	0.39	0.27

Fig. 5 Solubility of Refrigerant 21 in various mixtures of dimethyl ether of tetraethylene glycol and dimethyl formamide at 175 F

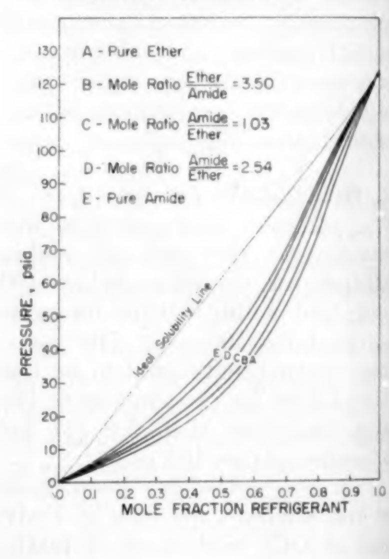
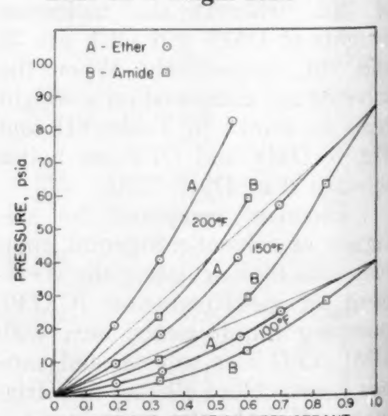


Fig. 6 Comparison of dimethyl ether of tetraethylene glycol and dimethyl formamide on a weight basis



considerations, both have relatively low boiling points, so that they might cause problems in an absorption refrigeration system. In this respect, N,N-dimethylacetamide has a considerably lower volatility and this compound should be tested in the future. The N,N-dialkylformamides may also require additional investigation to determine if they are adequately stable in a refrigeration cycle.

Although the ternary solutions used in this investigation did not increase solubility, they may prove useful in improving solvent properties such as viscosity, stability and corrosiveness. For instance, tetraethylene pentamine reacted with the refrigerant, but a 50:50 mixture of DME-TEG and tetraethylene pentamine did not appear to react.

In future work on ternary systems, it would be of interest to study the effects of adding a highly associated liquid or a polar salt to an organic solvent. Such additions might increase the solubility of the refrigerant in the solution.

CONCLUSIONS

Several nitrogen-containing organic solvents were tested; some amines, nitriles and formamides were found to be good solvents for Refrigerants 21 and 22, which contain a hydrogen atom and hence can hydrogen bond. The two best solvents found were dimethyl formamide and diethyl formamide. These two solvents produce mixtures that have C.O.P. about 15 and 2%, respectively, better than mixtures containing the dimethyl ether of tetraethylene glycol. C.O.P. values ranging from 0.27 to 0.44 were estimated for mixtures of the formamides.

Several binary mixtures were investigated as solvents for the refrigerant, but none of those tested showed improved solubility characteristics as compared to the pure compounds.

ACKNOWLEDGMENT

This investigation was sponsored by the Indiana Gas Association. Details and the unabriged data can be found in Allen Thieme's M. S. thesis, Purdue University (1960).

REFERENCES

1. Albright, L. F., Buclez, P. C., Pluche, C. R., and Doody, T. C., ASHRAE Transactions, 66, 423-433 (1960).
2. Copley, M. J., Zellhoefer, G. F., and Marvel, C. S., J. AM. CHEM. SOC., 60, 2666-73 (1938)
3. Copley, M. J., Zellhoefer, G. F., and Marvel, C. S., J. AM. CHEM SOC., 61, 3550-2 (1939).
4. Copley, M. J. Zellhoefer, G. F., and Marvel, C. S., J. AM. CHEM. SOC., 62, 227-8 (1940)
5. Eiseman, B. J., ASHRAE JOURNAL, 1 (No. 12), 45, (1959).
6. Ellington, R. T., Kunst, G., Peck, R. E., and Reed, J. F., "The Absorption Cooling Process," Institute of Gas Technology, Research Bulletin No. 14, August 1957.
7. Hildebrand, J. H., and Scott, R. L., "The Solubility of Nonelectrolytes", 3rd Ed., Reinhold Publishing Corp., New York, 1950.
8. Mastrangelo, S. V. R., J. PHYS. CHEM., 64, 608 (1959).
9. Mastrangelo, S. V. R., ASHRAE JOURNAL, 1 (No. 10), 64 (1959).
10. Servel, Inc., Personal Communication 1958).
11. Zellhoefer, G. F., IND. ENG. CHEM., 29, 548-51 (1937).
12. Zellhoefer, G. F., Copley, M. J., and Marvel, C. S., J. AM. CHEM. SOC., 60, 1337-43 (1938)

PRESIDENT'S PAGE

(*Continued from page* 58)

Laws, Public Relations Literature and other miscellaneous publications.

The JOURNAL has received a great deal of criticism in the past, much of which has been unjustified, some constructive and some negative. The Long Range Planning Committee is now studying methods by which the JOURNAL can be of more importance to the membership as well as more profitable to advertisers in order to increase our advertising income to the Society. Again, your suggestions will be welcome.

The GUIDE AND DATA BOOK, which is a combination of the ASHAE Guide and the ASRE Data Book, has been a most prodigious job requiring many hours of work on the part of the Committee and many hours on the part of Carl Flink, Staff Editor, and his assistant, Carl MacPhee. The results of the work of these people will be more than appreciated when the new volume is released next month.

The Transactions are the history of technical progress by our industry through papers contributed through industry and our own research programs. The cost of producing these Transactions has been reduced greatly by headquarters staff and they are thus available to the membership for a small additional cost.

The Standards which are published by the Society are recognized throughout the world and have been adopted not only by our own industry but by American Standards Association, International Standards Organization and many of our allied industries.

Regarding Research, we cannot deny that the past year has been rather a difficult one. Misinterpretation of facts, emotional stress and suspicion on the part of a few have been created by lack of knowledge of details. There is no question in my mind that every officer and every member of the Board of Directors is 100% behind a strong and vigorous program of Research. How this is done is a detail. The fact that it must be done is the important issue to which your Board of Directors is giving its wholehearted support. Your Board of Directors and your Long Range Planning Committee are composed of men of the highest standing in their profession, men of the highest integrity and men of prudent judgment. These men are dedicated in their work for the Society and to the interest of the membership. They certainly cannot be accused of self interest, misappropriation of membership interest or scuttling the Research activities of the Society.

We are a strong, healthy and vigorous Society and, now that the interim period of merging is over, we must devote our interests and energies to promoting our aims and objectives as a Technical Society. If we will do this in a spirit of cooperation and with unity of agreement, our progress will be inevitable.

Meetings ahead

August 15-17—Cryogenic Engineering Conference, University of Michigan, Ann Arbor, Mich.

August 21-31 – International Exhibition of New Sources of Energy, Rome, Italy.

August 23-26—International Institute of Refrigeration, Commission 5, Budapest, Hungary.

August 28-September 1—International Heat Transfer Conference, sponsored by the American Society of Mechanical Engineers and the American Institute of Chemical Engineers, Boulder, Colo.

September 20-22—International Institute of Refrigeration, Commissions 2, 3, 6A, 6B and 8, Cambridge, England.

September 27-October 4 – Institution of Heating and Ventilating Engineers, International Heating, Ventilating and Air Conditioning Conference, London, England.

October 2-4 – American Gas Association, Annual Convention, Dallas, Texas.

October 7-10 – Western Building Industries Exposition, Los Angeles, Calif.

October 23-27—National Metal Exposition, Detroit, Mich.

October 31-November 2 – Fourth Canadian Refrigeration and Air Conditioning Show, Toronto, Ont.

November 5-7—National Frozen Food Association, National Convention and Exposition, Bal Harbour, Fla.

November 6-10 – National Warm Air Heating and Air Conditioning Association, 48th Annual Convention, Chicago, Ill.

November 12-15 – Air Conditioning and Refrigeration Institute, Annual Meeting, Hot Springs, Va.

November 13-17 – National Electrical Manufacturers Association, Annual Meeting, Atlantic City, N. J.

January 28-February 1—American Society of Heating, Refrigerating and Air Conditioning Engineers, Semi-annual Meeting, St. Louis, Mo.

News of ASHRAE members

Honors and Recognitions

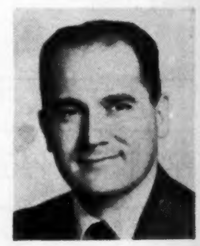
Leon L. Munier of Wolff & Munier is now Senior Vice President of the Mechanical Contractors Association of America. He was elected to that post at the 72nd Annual Convention of the Association, held May 9-12.

W. A. Maclinn, Director of The Refrigeration Research Foundation, was elected Secretary of the Foundation at its Annual Meeting, held March 26-28.

New jobs

R. E. Crossey, assisted by **Ross Lester** (both are members of Montreal Chapter) will head the newly opened Toronto office of Consulting Mechanical & Electrical Engineers of Montreal. Other Montreal Chapter members with new posts are: **Ralph Grossman,** now President of Combustion & Power Equipment, Ltd., and Secretary of Peabody Engineering Corporation of Canada, Ltd.; **Michael M. Fainstat,** elected Vice President of Combustion & Power Equipment, Ltd.; and **William Ross,** formerly with Vapour Car Heating, who has joined Howe Equipment Company.

Douglas E. Phillips was named Project Engineer and **Ernest S. Langer** was appointed Applications Engineer at Kohlenberger Engineering Corporation. The former has served as an applications engineer since 1955 and the latter is joining the company with a background of 12 years of consulting engineering experience.



George Sinichko has been appointed General Manager of the Michigan City, Ind., plant of Dunham-Bush, Inc. Prior to his appointment he was Acting General Manager and Assistant Secretary. Associated with the company since 1950, he has served as Sales Engineer, Product Manager, Chief Engineer and Production Superintendent. A graduate of Duke University with a B.S. degree in mechanical engineering, he also attended Muhlenberg College.

Anwar A. Atalla is now Engineering Manager of the Connecticut Air Moving Div of Torrington Manufacturing Company. As Chief Development Engineer, he had been responsible for several new products. A graduate of the University of Cairo, he also attended California Institute of Technology and Rensselaer Polytechnic Institute, receiving a B.M.E. degree from the latter in 1954. Active in ASHRAE and the American Society of Mechanical Engineers, he is currently serving on a Nema industry committee for standardization of equipment noise-testing procedures.

S. R. Hill has been appointed Central Region Sales Manager for the Air Conditioning Div of Westinghouse Electric Corporation. A 1948 graduate of the University of Oklahoma, he was employed by Trane Company until 1957. During 1958 and 1959, he was a partner in a consulting engineering firm.

Henry Karger is now Director of Engineering for Astro Products. Formerly Senior Project Engineer with Emerson Radio and Phonograph Corporation. he has also been a test engineer with the National Bureau of Standards. He was educated at Antioch College and Catholic University.

Lawrence H. Baker, appointed Eastern Regional Manager for Copeland Refrigeration Corporation, has been associated with air conditioning and refrigeration since 1947. Previous posts were as Sales Manager of Branch Operations with Chrysler Corporation Airtemp Div and New York District Manager for Dunham-Bush.

Joseph W. Flasch, named Product Manager, and **Carl M. Rice,** appointed Field Sales Manager, are two new appointments announced by Bell & Gossett Company.

Associated with a newly formed national service organization, established by Dunham-Bush, Inc., are: **Argo L. Mattison,** connected with application and service for the past four years at the Marshalltown, Iowa, plant; **James N. Blatt,** formerly with Brunner Manufacturing Company in various engineering capacities; and **Edward L. Cook,** a graduate of Massachusetts Institute of Technology and former Resident Engineer with Creamery Package Manufacturing Company. These men will be responsible to the general managers of the plants at which they are headquartered.

Thomas B. Simon has been named Manager of Room Air Conditioning Engineering for the Major Appliance Div of Westinghouse Electric Corporation. He succeeds **W. S. Reid.** Mr. Simon joined Westinghouse four years ago as an engineering section manager. Prior to that, he was Engineering Manager at Crosley. He is a 1943 graduate of Purdue University, with a degree in metallurgical engineering.

Frederick T. Taylor, Oregon Chapter past-President, is now a member of the firm of Mead & Associates. He had served as Manager of Rowland Plumbing and Heating for several years. **Floyd Chapman** of Oregon Chapter has announced his move from Pacific Pumping Company to Hydronix, Inc.

Robert C. Crowe has been appointed Cleveland District Sales Manager for Wolverine Tube Div, Calumet & Hecla, Inc. Joining the company in 1950, he subsequently served as a sales representative in several areas and as Manager of Product Sales in Allen Park, Mich. **J. A. Finnerty,** formerly a Wolverine Sales Representative in the Detroit area, is now Sales Representative in Dayton, Ohio.

Frank W. Brandon has been named Estimating Manager of Limbach Company's mechanical department. A 1948 electrical engineering graduate of Carnegie Institute of Technology, he is, in addition to ASHRAE, a member of the American Institute of Electrical Engineers.

Arthur M. Suggs has been promoted to Manager of the Columbia sales office of Trane Company. A mechanical engineering graduate of Clemson College, he joined Trane in 1948 and worked in the Greenville, S. C., sales office until 1950, when he joined the Columbia office.

Frank H. Gardner is Manager of the recently organized Aerospace Div of Tenney Engineering, Inc. With Tenney for ten years, he is a graduate of the College of the City of New York, also having attended Ohio State University and the Shrivenham Div of Oxford University in England.

E. Frank Morgan, Jr., has been named Purchasing Manager of the Mechanical Department of Limbach Company. Formerly Area Manager of Borg-Warner International Corporation, he is a 1954 graduate of North Carolina State College.

Benjamin T. Bootle advances to Manager of the Greenville, S. C., sales office of Trane Company, succeeding **Robert S. Knowles,** who is now manager of the Chicago office. An alumnus of the University of South Carolina, Mr. Bootle joined Trane in 1955.

Peter Butterfield, Northern Regional Manager for Acme Industries, has been appointed Assistant Field Sales Manager. With the company since 1953, he has served also in the technical data section, order service and application engineering departments and as a sales engineer in the New York Regional Office.

John E. Kirwan, with Trane Company since 1956, has been named Manager of the Aurora, Ill., sales office. He received a B.S. degree in mechanical engineering from Washington University in 1950.

Necrology

Paul H. Kroeschell, President and Treasurer of Kroeschell Engineering Company, died suddenly April 21, at sea enroute to Europe.

Others are saying—

heat pump installations . . . often are favored if a building requires cooling as well as heating. Other factors influencing selection of this type of system include climate (as outside temperature decreases, so does the coefficient of performance of a heat pump), comparative rates of electricity and alternate fuels and type of building. To arrive at load requirements, a careful study of internal heat gains and losses must be made, such as loss through exhaust air, infiltration-exfiltration losses and gains from sources such as electrical or industrial machinery and the lighting. *Air Conditioning, Heating and Ventilating, April 1961, p 58.*

solar heat protection . . . of buildings has become increasingly important with use of large areas of glass. Orientation of the buildings is a major governing factor in determination of the type of protective device to be used. Various methods cited are: horizontal or vertical sun shields, louvers (internal, external or between the glass panes of double glazed windows), heat absorbing glass and scattering of radiation. *Journal of the Institution of Heating and Ventilating Engineers, April 1961, p 16 (British).*

selection of air conditioning . . . and air distribution systems is influenced primarily by the basic size and shape of the building. Multistory buildings permit a wide latitude of choice, with high velocity air distribution systems usually favored. Characteristics of various systems to be considered are: conventional perimeter induction systems have a summer to winter changeover point at which water temperatures must be changed from cold to hot, with possible resultant tenant discomfort; fan coil systems have similar limitations during changeover, have higher maintenance costs and can produce excessive noise; and high velocity double duct and multizone systems usurp more building space, have higher operating costs and require a substantial warm-up period. *Consulting Engineer, June 1961, p 116.*

What ASHRAE Regions and Chapters are doing

Final meetings of the season featured election and installation of new Chapter officers, reports by committee chairmen, summaries of proceedings at the various regional gatherings and a wide range of technical discussions.

SOUTH FLORIDA . . . Economics and growth of business and population in Florida were covered at the April 11 meeting by Landon G. Haynes, Vice President of 1st Research Corporation. D. R. Carroll, Field Representative for Pace, Plumbing, Air Conditioning and Electrical Contractors, discussed that company.

who's doing what . . . Officers for the 1961-62 season are: Armand Cowan, President; James Beard, Vice President; A. R. Dickterenko, Secretary; K. D. Cunningham, Treasurer; and John Lotz and J. L. Middleton, Board of Governors.

Moderating a panel discussion at the May 9 meeting was J. L. Middleton; the subject was "What is Best For 15 to 75-ton Systems, Air or Water-Cooled Condensers?" Speaking for air-cooled units were E. Morris, C. King and W. Nichols; S. Shelton, S. Hamilton and A. R. Dickterenko were for water-cooled condensers.

OREGON . . . Development of air conditioning in this country was traced by David M. Dart of Marley Company, speaking on "Automatic Year-Round Air Conditioning Systems Using Air" at the April 13 meeting. Slides illustrated methods of reducing and increasing air-cooled condenser capacity.

who's doing what . . . Installed for the coming year were: President, Earl S. Constant; Vice President, James L. Waymire; Secretary, C. W. Timmer; Treasurer, William Maxwell; Board of Governors, Omer Jacobson and G. Stahl.

Defining medium temperature water as being approximately 300 F, but still capable of using 125-psig equipment, May 11 speaker G. F. Carlson, Chief Engineer, Specialty Div, Bell & Gossett Company, illustrated the savings in pipe size and pumping power required as water temperature drop is increased (see June 1961 JOURNAL). For example, with a 20-F drop, ten gpm are required for 100,000 Btu/hr, whereas with a 100-F drop, but two gpm are required for 100,000 Btu/hr. Speaker Carlson also showed how heating coils can be controlled more effectively by utilizing higher temperature drops.

who's doing what . . . New committee chairmen are: Meetings, J. L. Waymire; Membership, G. Stahl; Attendance, O. Matthews; Technical & Research, D. Benz; Student Assistance, R. Farnes; Diffuser, G. Van Alst; Social, R. Neffendorf and W. Brod; Symposium, W. Hayes and F. Taylor.

DALLAS . . . Reports were given at the May 15 meeting by Committee Chairmen F. L. McFadden, Program; W. P. Dickson, Publicity; Gail Risch, Hospitality; A. Smith, Attendance; D. Loosely, Technical; T. Rose, Reception; F. Hescock, Membership; and W. Keeney, Social Events. Elliott Hallowell, Co-Chairman of the Parliamentary Committee, gave a brief summary of the intent of the proposed Chapter By-laws.

President R. M. Kilpatrick called for a report from the Tellers' Committee, appointed to count the ballots of the election of officers for the 1961-62 season. Chairman Watson Keeney announced the following results: R. A. Osterholm, President; F. L. McFadden, 1st Vice President; A. A. Hooper, 2nd Vice President; Oslin Nation, Secretary; W. P. Dickson, Treasurer; Marvin Brown, Sr., R. M. Kilpatrick and J. P. Jordan, Board of Governors.

R. A. Osterholm then summarized proceedings at the Region VIII Meeting and Conference held in Shreveport. The 1962 meeting will be April 27-28 in Lubbock, Texas. P. N. Vinther was appointed Chairman of a Ways and Means Committee for this meeting.

Also announced were new chairmen of committees: Ivan McGuire and Gail Risch (Co-Chairmen), Program; H. V. Alexander, Membership; C. P. Wallis, Reception; Barton Wallace, Technical; Louis Mitchell, Attendance; Arthur Hundley, Publicity; Banks Clark and J. Bartos (Co-Chairmen), Hospitality; D. Hardin, Publications; A. Smith, Assistant Chairman, Publications; C. D. Saustad, Social Events; Morris West, Joint Meetings With Fort Worth Chapter; and George Meffert and Elliott Hallowell (Co-Chairmen), Parliamentary.

WESTERN MASSACHUSETTS . . . Speaking at the May 18 meeting, Paul Sackett of York Corporation described "Three-Pipe Air Conditioning Installation." Features of this system are low initial and operating cost, simplified design and flexibility of varying loads.

who's doing what . . . Harold Lambert was presented with a plaque and certificate of life membership.

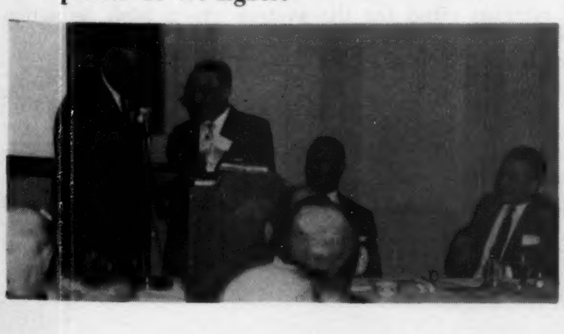
PHILADELPHIA . . . Detailing his experiences as a technical adviser to the Polish government, Otto J. Nussbaum was main speaker at the April 13 meeting.

who's doing what . . . Officers for the 1961-62 season are: Otto M. Kershock, President; David S. Plewes, 1st Vice President; Allen A. Lincoln, 2nd Vice President; P. Russell Anderson, Treasurer; Otto J. Nussbaum, Recording Secretary; Kenneth M. Wicks, Corresponding Secretary; Ludwig Mack and John Benson, Board of Governors. Otto M. Kershock and Ludwig Mack are Delegate and Alternate, respectively, to the Chapters' Regional Committee.

ASHRAE First Vice President John Everetts, Jr., third from left in the front row, sat with past national and New York Chapter presidents. Fourth from the right in the same row is ASHRAE's elder statesman, Presidential Member Henry Torrance (1914).

NEW YORK . . . Guests of honor at the May 23 meeting were 21 past presidents of the New York Chapter of ASHRAE and its predecessor societies, ASHAE, ASHVE and ASRE, dating back to 1919. Prominent in New York industry, they were: ASHRAE: Leonard D. Carr (1959-60); ASHAE: W. J. Olvany, Jr. (1958-59), C. R. Hiers (1957-58), J. B. Hewett (1956-57) and Albert Giannini (1955-56); ASHVE: R. L. Stinard (1954-55), P. B. Gordon (1952-53), Ernst Graber (1951-52), C. F. Kayan (1950-51), H. S. Johnson (1949-50), H. J. Ryan (1945-46), A. J. Offner (1930-31) and R. A. Wolff (1927-28); ASRE: J. A. Endweiss, Jr. (1956-57), S. W. Brown (1955-56), C. W. Hudzietz (1954-55), A. I. McFarlan (1949-50), J. F. Stone (1937-39), James Larkin (1936-37), C. F. Holske (1935-36) and Henry Torrance (1919-21). Five of these men who have served as national presidents are P. B. Gordon (1957), C. F. Holske (1948), A. J. Offner (1946), J. F. Stone (1945) and Henry Torrance (1914).

Chapter past president Leonard D. Carr presents a plaque to out-going New York Chapter President Jerome M. Morse (behind podium). Attentive are national First Vice President John Everetts, Jr., and guest speaker C. W. Egbert



Also present as special guests were: H. D. Edwards, ASRE National President in 1930; W. M. Heebner, New York Chapter Treasurer in 1932 and 1958; John Everetts, Jr., ASHRAE First Vice President; M. C. Turpin, ASHRAE Executive Secretary Emeritus; A. T. Boggs, III, ASHRAE Technical Secretary; and J. H. Cansdale, ASHRAE Assistant Secretary – Public Relations and Fund Raising.

Presence of so many past presidents of the Chapter marked the retirement from office of the current president, Jerome M. Morse, and the incoming term of Scott A. Spencer. Mr. Morse was presented with a commemorative plaque by Chapter past president Leonard D. Carr.

Multi-room buildings represent quite a sizeable segment of the air conditioning market. Many different types of systems have been utilized for peripheral spaces with varying degrees of success and with varying economic results and operating characteristics. Representing a new approach, the three-pipe system was discussed at this meeting by C. W. Egbert of York Corporation.

WESTERN MASSACHUSETTS . . . History and progress of the cast iron boiler industry were traced at the March 30 meeting by S. H. Smith of H. B. Smith Company. Slides showed boiler construction from as early as the 19th Century.

who's doing what . . . R. E. Cady, W. B. Murphy, A. M. Lovenberg, R. Bunn and F. Loring were appointed members of the Nominating Committee.

Two basic cycles of absorption systems using lithium bromide were discussed at the April 27 meeting by Robert Doyle of Carrier Corporation. Cycle operation was demonstrated by use of schematic and pressure-temperature, pressure-volume diagrams. Advances in the field cited were use of a closed cycle on chilled water supply and improved methods of control. Charts showing load

energy consumption per ton using the absorption cycle as compared with centrifugal equipment were used for demonstration of the low power requirements per ton of refrigeration on the absorption cycle. Two basic advantages of the absorption machine, speaker Doyle stated, are use of heat as the primary source of energy and the fact that there are relatively few moving parts.

who's doing what . . . Proposed by the Nominating Committee are: C. Martin, Jr., President; K. W. Maki, 1st Vice President; J. Tropp, 2nd Vice President; T. Best, Secretary; and W. Rochford, Treasurer.

TUCSON . . . Placing emphasis on sound attenuation in high velocity systems, Ray Richardson of Tuttle & Bailey Pacific, Inc., spoke at the April 4 meeting on "Air Distribution and Sound".

Adoption of the revised 1960 Model By-laws was recommended by the Board of Governors with two exceptions: addition of Chapter boundaries and acceptance of the National recommendation that the Regional Delegate and Alternate be elected from the Board of Governors.

who's doing what . . . New Chapter officers are: D. Shipley, President; J. P. Jones, Vice President; E. Hamilton, Secretary; B. Dehlinger, Treasurer; and F. Blackmore and D. Heskett, Board of Governors.

Members attending the May 2 meeting were taken on a tour of the main office of Mountain States Telephone and Telegraph Company.

IOWA . . . Discussed at the May 8 meeting was "Application of Flexible Joints". Speaking was Robert Quick of Flexonic Corporation.

who's doing what. . . D. Wells, R. Howard and D. C. Murphy were members of the Nominating Committee that prepared the following slate of officers: V. G. Polly, President; E. G. Giberson, Vice President; L. L. Kelley, Secretary; J. R. Bain, Treasurer; J. Welsh, R. Schilling and R. Flanagan, Board of Governors.

CINCINNATI . . . Existing regulations for administering unemployment compensation claims were discussed at the April 4 meeting by Paul Endejann, formerly with the Ohio State Bureau of Unemployment Compensation.

who's doing what . . . Elected to office for the 1961-62 term are: C. P. Wood, Jr., President; C. J. Kummer, Vice President; N. E. Rau, Secretary; J. W. Gibbs, Treasurer; and W. J. Davis, Board of Governors.

HAMPTON ROADS . . . Speaking at the March 22 meeting was Edwin A. Kovner, Director of the Technical Institute of Norfolk Branch of William and Mary College. His discussion was concerned with operation and aspects of post-high school education, aimed at producing competent technicians.

JOHNSTOWN . . . March speaker was Howard Hill, Executive Vice President of the Greater Johnstown Chamber of Commerce.

who's doing what . . . Proposals of the Nominating Committee are: President, G. C. MacAlarney; Vice President, C. V. Barnhart; Secretary, M. J. Hostetler; Treasurer, M. E. Rose; Board of Governors, W. W. Popyk and W. M. Chapple.

Elected to office at the April 11 meeting were those members proposed by the Nominating Committee in March, with the addition of J. K. Thornton as a member of the Board of Governors.

NATIONAL CAPITAL . . . Speaking at the April 12 meeting was Warren Blazier, Jr., of York Corporation. His topic was "Noise Control".

who's doing what . . . New Chapter officers are: W. C. Hansen, President; R. J. Ruschell, Vice President; W. V. McCoy, Secretary; and W. H. Hobbes, Jr., Treasurer.

NEW ORLEANS . . . T. A. Aucoin, Jr., Special Projects Engineer, Kaiser Aluminum and Chemical Corporation, spoke at the April 18 meeting on "Fume Control Facilities at the Chalmette Works." An aluminum reduction plant, the installation uses a "cell" or "pot," consisting of an anode and a cathode, the shell of the pot being the cathode. Oxygen is driven off by electrical energy in the form of heat, combining with the carbon of the anode to form CO_2 gas, which is collected by the fume control system. Originally, the installation used a scrubbing system, which has since been revised to discharge gases high enough to disperse them to the atmosphere without affecting the surrounding area. Centrifugal fans were selected after consideration of blade erosion and other problems. The foundation of the main stack is comprised of 130-ft concrete piles, on which is a slab four ft thick at the edge and ten ft thick at the center. The stack itself is 500 ft high, 40 ft diam at the top and 50 ft diam at the bottom. Eight scrubber hoses each handle 44,000 cfm of air, with the entire system handling approximately 5,184,000 cfm and giving a velocity of 4000 fpm at the stack nozzle.

who's doing what . . . Officers for the 1961-62 season are: J. H. Maloney, President; R. D. Lewis, Vice President; J. F. Albright, Jr., Secretary; J. I. Hebert, Jr., Treasurer; H. E. Faller and G. E. Sullivan, Board of Governors.

MONTREAL . . . Using slides to supplement his discussion, April speaker F. Wood of York Corporation concentrated on the induction system as contrasted to fan coil and other applications. The three-pipe system was compared with the two-pipe induction system and conditioning requirements of curtain wall buildings were demonstrated. Critical components cited for the system are a high induction unit and non-mixing three-way control valve.

SACRAMENTO VALLEY . . . Illustrating his talk with color slides, David M. Dart of Marley Company spoke at the April 5 meeting on "Year-Round System Operation Using Air-Cooled Condensers".

who's doing what . . . Leonard Stecher and T. Andrews are Chapter representatives to the Region X Meeting.

Reporting at the May 3 meeting were: T.

Andrews, who covered the Region X Meeting; John Handy, giving the Treasurer's report; James Delavan for the Membership Committee; and Chairman E. C. McKinney of the Nominating Committee. Proposed for Chapter office are: L. S. Stecher, President; J. R. Handy, Vice President; M. Laks, Secretary; D. Yoshbo, Treasurer; W. B. Lander, F. H. Taylor and W. Nero, Board of Governors.

Speaker for the evening was Joseph W. Clancy, Div of Architecture, State of California. Discussed was design of high velocity systems.

HOUSTON . . . Clarence Fleming reported at the April 28 meeting on the Regional Meeting in Shreveport. D. Dana Price covered activities of the joint Engineers' Council in the Science Fair.

"Thermoelectric Cooling and Heating" was discussed by L. V. Eidson, Application Engineer, Industrial Section, University of Houston. Progress of thermoelectricity was traced from a laboratory phenomena to its present practical use in special applications. Most commonly used for semiconductors is bismuth telluride. For practical applications, thermocouples normally are used in series and parallel electrical circuits. Applications cited include: electrical component coolers, biological temperature chambers, small household appliances and a dehumidifier for basements.

CENTRAL MICHIGAN . . . Speaking at the May 9 meeting, Professor D. J. Renwick of Michigan State University covered "Sizing of Refrigeration System Pipelines for Optimum Economy" (see April 1961 JOURNAL). Solution of pipe design problems requires knowledge of the following elements, he stated: condensing and evaporator temperature, system capacity and efficiency, electrical cost, equivalent length rates and annual running time.

SAINT LOUIS . . . May speaker was G. F. Carlson, Chief Engineer, Specialty Div, Bell & Gossett Company, who discussed "Medium Temperature Water Systems." A low temperature system was defined as having a water temperature below 212 F; medium temperature systems as above 300 F and high temperature systems above 400 F. Systems in which the water temperature exceeds 212 F must be pressurized. Economically, speaker Carlson stated, it is sound to use a high temperature drop, since heating pipes can be reduced in size and the pump hp can be decreased, however, temperature control becomes more complicated.

PUGET SOUND . . . "Evolution of Refrigerant Flow Control Devices on Heat Pump Systems" was traced at the April 14 meeting by William H. Krack of Sporlan Valve Company. A question and answer period followed.

who's doing what . . . Elected to office are: Keith Massart, President; R. Kirkwood, 1st Vice President; D. M. Hopkins, 2nd Vice President; D. Moore, Secretary; H. Bickel, Treasurer; C. Hall, D. Ervine and F. Nuyens, Board of Governors.

R. Kirkwood, speaking at the May 9 meeting, reported on the Region X Meeting in Phoenix. The 1962 Regional Meeting will be held in Seattle and the 1963 meeting in San Diego. Also discussed were Chapter By-laws and the UEC Building Fund Drive.

"Medium Temperature Water and Its Design Considerations" was covered by G. F. Carlson, Chief Engineer, Specialty Div, Bell & Gossett Company.

NORTHERN CONNECTICUT . . . Conducted on an informal basis, a forum held at the April 13 meeting covered "Proper Application of Air-Cooled Refrigeration Condensing Equipment".

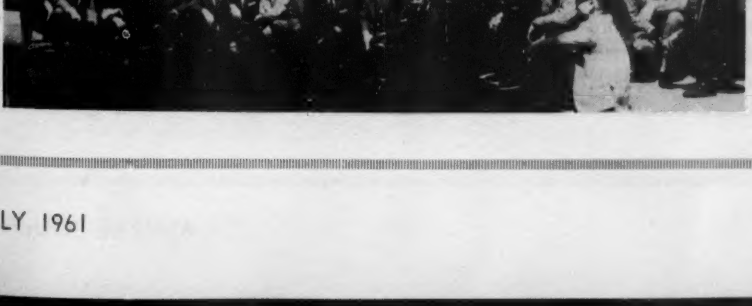
Speaker of the evening was S. Quarles, Assistant Supervisor, Engineering and Loss Control Div, Travelers Insurance Company, who detailed problems involving insurance coverage of refrigeration and related equipment.

Installed at the May 18 meeting, new officers of this Chapter are: Alan S. Decker, President; E. Johnson, 1st Vice President; H. Cosentino, 2nd Vice President; M. Fierberg, Secretary; and E. Nichols, Treasurer.

"Chemical dehumidification has two main divisions, solid desiccants and liquids," stated May speaker E. A. Windham of J. B. Hewett Company. He also indicated that chemical dehumidification is adapted primarily to industrial processes, although it is now being used in commercial enterprises, especially hospitals, because of its ability to destroy bacteria. Typical systems and installations were described with the aid of charts and slides.

SOUTHERN CALIFORNIA . . . Mechanical facilities at the Titan and Atlas test and launch site installations were described by William P. Scott, Jr., head of Scott Company and guest speaker at the April 10 meeting. Covered were several types of equipment under construction, changing requirements during construction and future use in interspace travel and study.

who's doing what . . . Nominations include: Presi-



Members of Kansas City and St. Louis Chapters are shown here as they met for a tour of the research facilities at the University of Missouri in Columbia, April 14, 1961

dent, J. C. Hall; Vice President, B. L. Hutchinson; Secretary, J. R. Hall; Treasurer, V. J. Burke; Board of Governors, A. A. Hellman, R. H. Jorgensen, M. Kodmur and P. A. Van Woerkom.

EVANSVILLE . . . Beginning his discussion with an explanation of the basic terms used in pump selection, Ralph Janetz, Bell & Gossett Company, spoke at the May 2 meeting on "Pumps, Their Application and Maintenance." Covered were suction lift, static discharge, total static hd, friction hd, velocity hd and total dynamic hd.

NEW MEXICO . . . "Rating of Equipment by the Sound Power Level Method" was discussed at the April 19 meeting by D. Neviaser of Carnes Corporation.

who's doing what . . . Nominated are: V. Stephens, President; D. Paxton, Vice President; J. Desilets, Secretary; W. Beale, Treasurer; G. Sebree, P. Hood and L. Classen, Board of Directors.

WISCONSIN . . . Host of a March tour of the AC Spark Plug plant at Oak Creek, Wisc., was E. Latus, who explained operation of the installation. Members were then divided into groups, with a guide assigned to each, to tour the area.

D. N. Crosthwait, Engineering Consultant, Dunham-Bush, Inc., spoke at the April 17 meeting on "Design and Application of High Temperature Water Systems – Temperatures from 250 to 450 F and Pressures from 55 to 450 psig."

who's doing what . . . F. W. Goldsmith read the report of the Nominating Committee, which proposes the following as officers for the 1961-62 season: President, W. H. Miller, 1st Vice President, K. F. Waraczynski; 2nd Vice President, F. W. Goldsmith; Treasurer, R. H. Schulz; Secretary, G. A. Adlam; Board of Governors, J. G. Eagle and J. E. Douglas. O. V. Hoium and P. Sukalich will be Tellers for the election.

SOUTHERN ALBERTA . . . Various types of motor control equipment were demonstrated by March speaker D. Bell of R. L. Brews & Sons, Ltd., in his discussion of motors and motor control. A question and answer period followed.

who's doing what . . . Nominating Committee Chairman W. Jack reported the results of elections as follows: President, N. J. Howes; Vice President, E. W. Deeves; Secretary, O. Reggin; Treasurer, V. Willis; Board of Governors, D. Bell, J. Orr, W. Roe, F. Thompson and J. Hole.

CENTRAL PENNSYLVANIA . . . Illustrating his talk with slides, May speaker William McCloskey of John J. Nesbitt Company discussed "Education and Air Conditioning". Details of air conditioning in both new and existing schools were covered.

MISSISSIPPI . . . "Dividend Engineering," a service developed by Owens Corning Fiberglas Corporation to assist engineers in evaluation of thermal performance of building construction, was discussed at the May 22 meeting by Engineering Specialists Walter Boden and James McCauley. Films illustrated their presentation.

who's doing what . . . New Chapter officers are: C. E. Strahan, Jr., President; L. J. Beasley, Vice President; W. P. Harvey, Treasurer; P. R. Maxson, Secretary; Bowden Palmer, Burt Lomax and W. D. Fortner, Board of Governors.

ITALIAN OVERSEAS BRANCH . . . Elected to office for the coming year are: President, G. F. Bertolini; Vice President, L. Chieregatti; Secretary, G. du Bot; Treasurer, U. Stefanutti; Board of Governors, L. Jovane, A. Stradelli, M. Santagostino, E. Barbieri and L. Mazzini.

MIDDLE TENNESSEE . . . D. Neviaser of Carnes Corporation spoke at the April 11 meeting on "Rating of Equipment via the Sound Power Level Method."

New combined heat gain calculations being proposed by the NWA, ARI and IBR were discussed at the May 9 meeting by H. T. Gilkey, Director of Technical Service for the National Warm Air Heating and Air Conditioning Association.

who's doing what . . . Elected to office were: D. E. Nichols, President; E. W. Moats, Vice President; R. L. Bibb, Jr., Secretary; R. H. Wood, Treasurer; C. E. Amich and Faulkner Hickerson, Board of Directors.

WICHITA . . . "New Developments in Motors – Type and Application" was covered by March speaker R. G. Wickstrom of General Electric Company.

Jobbers, Inc., presented a film at the April meeting on "Development, Design and Manufacture of the Carrier Micronite Compressor."

CENTRAL NEW YORK . . . Discussed at the March 8 meeting was "Vibration and Noise Control for Air Conditioning Equipment", presented by Jack Harris of Korfund Company. Covered were theory of vibration, noise control and characteristics and limitations of various isolation media, such as steel springs, rubber and cork.

Principal speaker at the May 10 meeting was W. E. McConnaughy, whose topic was "Submarine Atmosphere Control and Environment". Requirements for air conditioning in a confined space, air purification and rejuvenation were discussed.

GOLDEN GATE . . . R. C. Pribuss, delegate to the Regional Meeting, reported at the May 4 meeting. Covered were problems of the merger, activities of other chapters, the UEC Building Fund Drive and biographical questionnaires.

Chairman of the Tellers Committee, J. Beck, reported the following results of the election of Chapter officers: R. C. Pribuss, President; D. A. Delaney, Vice President; L. E. Dwyer, Secretary; J. D. Kniveton, Treasurer; T. Brewer, G. L. Gendler and J. Kasin, Board of Governors.

Guest speaker was Albert Bruce, Supervising Mechanical Engineer, Pacific Gas & Electric Company. Generation of electricity from geyser steam

was discussed and the talk was accompanied by a slide presentation.

FLORIDA WEST COAST . . . Speaking at the February 21 meeting was George Register of Register & Cummings, who showed slides taken at the Moscow Fair.

President K. W. Whittington announced the proposed formation of a new chapter in the Orlando area.

SAVANNAH . . . F. L. Clupper of Carrier Corporation showed slides and presented an analysis of compressors at the April 18 meeting.
who's doing what . . . Nominated for office are: E. F. White, President; R. E. Kinser, Vice President; J. H. Baker, Secretary; J. M. Cates, Treasurer; R. A. Craig, Jr., and C. Courtenay, Board of Governors.

MICHIGAN . . . Engineers often fail to take advantage of economies available through staging the refrigeration equipment, using interior heat for exterior areas and removing lighting loads with return air, stated April speaker A. I. McFarlan in a discussion of "Getting the Most From a Three-Pipe System".
who's doing what . . . Life Membership Certificates were presented to G. W. Akers, H. E. Keeler and G. D. Winans.

AUSTIN . . . "Electrical, Mechanical and Chemical Loadings of a Heat Pump Compressor" was the topic of March speaker Dubberly of the General Electric Company. Regional Director W. J. Collins, Jr., was present and urged members to attend the Regional Conference in Shreveport, April 21 and 22.
who's doing what . . . Nominated for office are: B. J. Barnhart, President; W. M. Fairchild, Vice President; W. C. Milstead, Secretary; B. N. Walton, Treasurer; John Ascherl and Pike Dobbins, Board of Governors.

James Brock of Armstrong Cork Company presented a discussion at the April 20 meeting on a progress report of Armstrong research in "Building Weather." A slide film showed effects of indoor weather on air conditioning piping.
who's doing what . . . W. C. Milstead declined the nomination as Secretary; E. G. Bloomquist has been designated in his place.

EL PASO . . . Shown at the May 15 meeting was a film, "Control of Bacteria in Hospitals". George Jackson, Delegate to the Chapters Regional Committee Meeting on April 24, reported on the proceedings.

CENTRAL INDIANA . . . At the annual election meeting of this Chapter on May 9, William L. Kercheval became President. Also elected were: R. I. Drum, 1st Vice President; Hugh Johnson, 2nd Vice President; S. E. Fenstermaker, Jr., Secretary; I. M. Slepicka, Treasurer; A. B. Keller, Robert Dimmich, Jules Lerzak and Winston Kelley, Board of Governors.

Featured at the meeting was presentation of the 6th Annual William Todd Miller Award, in honor of Purdue University Professor Emeritus W. T. Miller, Fellow ASHRAE. Receiving the award was Carl Grinstead, a June graduate of Purdue. Runners-up were John Kamman and George Rawlinson.

COLUMBUS . . . Taking office June 1 were Emil Stluka, President; George Reverman, 1st Vice President; John Hensel, 2nd Vice President; H. Barnebey, Secretary; R. Bement, Treasurer; W. Taylor and E. Saurborn, Board of Governors.

At the May 15 meeting members discussed the various aspects of the profession with which they are involved.

OREGON STATE COLLEGE . . . R. C. Chewning of J. Donald Kroeker & Associates was guest speaker at the April 5 meeting. "Commercial Heat Pump Applications" was the subject under discussion.

"Refrigeration Applications and Design Problems" was covered at the May 3 meeting by William Sarine of Webster Engineers.

NORTH ALABAMA . . . High velocity air conditioning system design was covered at the April 12 meeting by R. D. Schmidt of Barber-Colman Company.
who's doing what . . . To serve for the 1961-62 term are: G. R. Jackson, President; J. H. Judd, 1st Vice President; S. S. Simpson, Jr., 2nd Vice President; W. E. Cone, Secretary; D. L. Daily, Treasurer; J. J. Keith, Delegate; R. W. McKenzie, Alternate; L. H. Eberdt, Jr., J. A. Evans, W. L. Wayman and G. W. Hogan, Jr., Board of Governors.

NIAGARA FRONTIER . . . Membership Chairman H. J. McLaughlin, reporting at the May 8 meeting, announced that ten new members have been added to the Chapter in the last year. Elections were held and new officers are: R. W. Bartsch, President; H. J. McLaughlin, 1st Vice President; A. F. Worden, Jr., 2nd Vice President; Robert Jorgensen, Secretary; and R. L. Jameson, Treasurer.

KANSAS CITY . . . Slides of the building of a missile base and warning radar network in Greenland were shown at the May 1 meeting by John T. Ames of Natkin & Company.

NEBRASKA . . . "Proposed Air Conditioning System for the Nebraska State Capitol Building" was discussed by May speaker Xavier Hoffmann.

OTTAWA VALLEY . . . Speaking at the April 18 meeting was D. Adamson, Chief Economist of Central Mortgage and Housing Corporation.
who's doing what . . . Nominations include: P. G. Fortier, President; J. D. Partington, Vice President; I. M. Patterson, Secretary; D. C. McKeen, Treasurer; A. Oaks, V. Herbert, R. Legare, F. Richardson and A. Simmonds, Board of Governors.

BOSTON . . . Covered at the Board of Governors meeting of April 18 were the Nominating Committee report, Chapter By-laws, the UEC Building Fund progress and the Region I Meeting.

Candidates for ASHRAE Membership

Following is a list of 95 candidates for membership or advancement in membership grade. Members are requested to assume their full share of responsibility in the acceptance of these candidates for membership by advising the Executive Secretary on or before July 31, 1961 of any whose eligibility for membership is questioned. Unless such objection is made these candidates will be voted by the Board of Directors.

Note: * Advancement † Reinstatement

REGION I

Massachusetts

MCGRATH, W. H., Cons. Engr., Lexington.
THOMAS, W. K.,* Chief Engr. & Associate, Fred S. Dubin, Assoc., Boston.

New Jersey

MONSEN, R. R., Sales Engr., Monsen Refrigeration Service, Bloomfield.
THULIN, G. S.,† Appl. Engr., Danfoss, Inc., Lodi.

New York

BALL, S. E., Appl. Engr., Aerofin Corp., Syracuse.
BRADICICH, H. S., JR., Design Engr., Krey & Hunt, New York.
CROOKS, G. A., Repr., Johns-Manville Corp., New York.
DICKASON, D. R., Sales Engr., Genesee Heating Service, Inc., Rochester.
DIVNEY, J. M., Design Engr., Krey & Hunt, New York.
FOLLANSBEE, J. W., Design Draftsman, Voorhees Walker Smith Smith & Haines, New York.
GRAY, C. F., Sales Mgr., Union Carbide Corp., New York.
HULTGREN, E. E., Plant Engr., National Broadcasting Co., New York.
MURPHY, T. J., Mech. Engr., Grumman Aircraft, Bethpage.
POWELL, H. R., Design Engr., Cryotec Mfg. Co., Inc., Gardiner.
THOMPSON, R. F., Group Supvsr., Carrier Air Conditioning Co., Syracuse.

REGION II

Canada

ALLEN, E. D., Repr., Ideal Stoker Co., Ltd., Toronto, Ont.
BUTLER, P. M.,* Pres., Angus, Butler Engineering Ltd., Edmonton, Alberta.
CUMMINGS, ROBERT, Sales Engr., Sheldons Engineering, Toronto, Ont.
DOAN, H. R., Sr. Field Engr., Powers Regulator Co., Downsview, Ont.
FRIEDMAN, C. H., Field Supvsr., Jas. P. Keith & Assoc., Montreal, Que.
MILNE, G. A., Repr., American-Standard Products, Toronto, Ont.
PAGON, R. N., Sales Engr., Pagon & Little, Rexdale, Ont.
PELLETIER, PIERRE, Mgr., Atlas Webster Industries, Montreal, Que.
SUTTIE, G. C., Dist. Repr., Bird-Archer Co., Cobourg, Ont.

REGION III

District of Columbia

BROGGINI, E. L., Engr., U. S. Army, Office Chief of Engineers, Corps of Engineers, Washington.

Pennsylvania

COWART, W. J., Sales Engr., The Trane Company, Philadelphia.
GILMOUR, NEIL, JR., Regional Mgr., Westinghouse-Sturtevant, Philadelphia.
MILLER, W. K., JR.,* Chief Designer Wm. H. Glasgow, York.
PENNYPACKER, D. B., Sales Engr., Marlo Coil Co., Bala Cynwyd.
SHORT, E. P., JR.,* Assoc., F. W. Shimmel Co., Lancaster.
TARLETON, D. B.,* Chief Engr., Barton Engineering, Philadelphia.

REGION IV

Florida

KLIPPERT, R. V., Sales Repr., Buffalo Forge Co., Tampa.
MARTIN, A. N., Design Engr., Ebaugh & Goethe, Gainesville.
WALCOFF, BARTON, Chief Engr., Dublin Co., Miami.

Georgia

BEVERLY, J. R., Asst. Ind. Engr., Atlanta Gas Light Co., Atlanta.
MCDANIEL, A. A., Secy.-Treas. & Mgr., Waycross Plumbing Co., Waycross.

North Carolina

CASHIN, W. A., JR., Service & Installation Mgr., Minneapolis-Honeywell Regulator Co., Greensboro.
THOMPSON, W. L., JR., Htg. & Cooling Spec., Carolina Power & Light Co., Raleigh.

REGION V

Indiana

HOLBEY, NICHOLAS, Design Engr., Purdue University, W. Lafayette.

Ohio

PROFITT, W. C., Sales Engr., Delco Products, Dayton.

REGION VI

Illinois

BURTON, J. F., Engr., Quaker Oats Co., Chicago.
ELLIS, D. L., Sales Engr., Powers Regulator Co., Peoria Heights.
KLEMM, B. J., Supvsr. Indus. Sales, The Peoples Gas Light & Coke Co., Chicago.
MARTIN, B. E., Br. Mgr., Frick Company, Skokie.
OLSEN, R. C., Sales Engr., The Peoples Gas Light & Coke Co., Chicago.
PLANT, H. W., Chief Mech. Engr., Meissner Engineers, Inc., Chicago.
SCHULTZ, A. A., Sales Engr., Frick Company, Skokie.
SIMQU, S. L., JR., Appl. & Sales Engr., Frick Company, Skokie.

Michigan

MURRAY, F. L.,* Owner, Murray Engineering Co., Battle Creek.
SCHLAFER, H. V., Estimator, Harrigan & Reid, Oak Park.

Minnesota

ORRICK, E. F., Engr. & Mgr. Vtg. Dept., Walker Jamar Co., Duluth.

South Dakota

ANDERSON, E. O., Owner, Edwin O. Anderson, Sioux Falls.
BASTIAN, K. K., Engr., Howard Parezo & Assoc., Sioux Falls.
BERG, M. L., Mech. Engr., Hugill, Blatherwick, Fritzel & Krieger, Sioux Falls.
CONRAD, J. R., Div. Engr., Central Electric & Gas Co., Sioux Falls.
EGAN, J. W., Br. Mgr., Johnson Service Co., Sioux Falls.
FARKAS, F. S., Vice-Pres., Shamrock Systems, Inc., Sioux Falls.
HOWE, R. C., Htg. & Plbg. Contractor, Sioux Falls.
MEYERHOFF, L. F., Gen. Mgr., C. J. McDermott Co., Sioux Falls.
MILLER, DUANE, Mech. Engr., Harold Spitznagel & Associates, Inc., Sioux Falls.
MOSER, W. S., Mech. Draftsman, Harold Spitznagel & Associates, Sioux Falls.
ROBINSON, W. F., Pres. & Treas., Girton-Adams, Sioux Falls.
SWENSON, R. M., Self Employed, Sioux Falls.
WOOD, R. W., Ind. Sales Engr., Northern States Power, Sioux Falls.

Wisconsin

GOLDSMITH, F. W., Sales Engr., W. Clasmann Co., Milwaukee.

ROOM AIR DISTRIBUTION SHOULD ASSURE A COMFORTABLE, UNIFORM ENVIRONMENT PAGE 41

REGION VII

Louisiana

BURKE, R. D., Appl. Engr., Air Conditioning Appliance Corp., Alexandria.

Tennessee

BURTON, J. R., III, Exec. Vice-Pres., Fixturcraft, Inc., Nashville.
LITTLE, R. M., Sales Mgr., Minneapolis-Honeywell Regulator Co., Nashville.

REGION VIII

Oklahoma

GIBBONS, P. J., Indus. Specialist, Owens-Corning Fiberglas Corp., Oklahoma City.
IRWIN, R. R.,† Assoc. Prof. Mech. Engrg., Oklahoma State University, Stillwater.

Texas

GOODWIN, W. R., III, Design Appl. & Sales Engr., Marshall, Neil & Pauley, Inc., Houston.
HOLSTE, F. R., Owner, Fred R. Holste & Associates, Houston.
SEELMAN, R. N., Sales Engr., Eggelhof Engineers, Inc., Dallas.
SMITH, G. C.,* A-C Test Project Engr., Ed. Friedrich, Inc., San Antonio.

REGION IX

Nebraska

PETERSON, J. W., Design Engr., Natkin & Co., Omaha.

Texas

HOLLAND, J. A.,* Partner, H P B Control & Equipment Co., El Paso.
HOYLE, B. K., Repr., Minneapolis-Honeywell Regulator Co., El Paso.

REGION X

California

BOGART, A. D., Partner, Bogart-Bullock Corp., Los Angeles.
HALPERN, MARSHALL, Sales Mgr., Airfan Engrg. Co., Los Angeles.
IVES, G. J.,† Asst. Mgr., Holbrook Refrigeration Inc., Los Angeles.
KNAUSS, J. W., Mfrs. Repr., Natural Gas Equipment Inc., Sacramento.
SELLERS, K. H., Assoc. M. G., State Div. Architecture, Los Angeles.
SKEELS, E. B., JR., Sales Engr., Owens-Corning Fiberglas Corp., San Francisco.
WESTERFELD, R. C., Chief Mech. Engr., Daniel, Mann, Johnson & Mendenhall, Los Angeles.

Oregon

COOPER, W. S.,* Br. Mgr., American-Standard, Ind. Div., Portland.

Washington

ERVIN, D. A., JR.,* Partner, Kane & Ervin, Engineers, Seattle.
LUALLIN, D. E., Repr., The Trane Co., Seattle.

Students

BUDKE, P. E., Oregon State University, Corvallis.

FOREIGN

England

DYE, B. J. M., Technical Supt., Petters Ltd., Hamble.

Germany

VIESSMANN, HANS, Pres., Stahlheizkessel-Verbandes, Hagen.

India

RAMAN, B. V. C., Chief Engr., Hindustan Antibiotics Ltd., Pimpri.

Iraq

ASHOO, K. A., A-C. & Refrig. Engr., Basrah Petroleum Co., Ltd., Basrah.

Mexico

LLOP, J. P., Chief Engr., Ferocarril del Pacifico, Guadalajara.

Netherlands

STOLK, A. L., Chief Engr., Grasso's Royal Works, 's-Hertogenbosch.

New Zealand

CHARLES, A. L., Partner, George Vamos, Wellington.

BULLETINS

Liquid Phase Heater. Extensive specifications for the Hi-R-Temp liquid phase heater are given in eight-page Bulletin 4023. By means of high transfer oils, high temperatures are cited as being achieved without accompanying high pressures. The unit modulates automatically, operates to 600 F, requires no water treatment, is unitized and is available in sizes from 1,250,000 to 4,375,000 Btu/hr.
Vapor Heating Corporation, 6420 W. Howard St., Chicago 48, Ill.

Straight Line Diffusers. Information on Architectural Straight Line Air Diffusers is provided by eight-page Catalog ASL-70, which contains extensive application and selection data. Given also are performance tables on continuous wall-to-wall, ceiling mounted or wall mounted diffusers.
Anemostat Corporation of America, 10 E. 39th St., New York 16, N. Y.

Pumps, Return Systems. Discussed in Flyer A-300 are boiler feed water pumps and condensate return systems. "Save Condensation" systems are designed to return hot condensate to 150-hp and larger steam boilers operating at pressures to 300 psig, or wherever gravity return to the boiler is impractical. Included in the bulletin are dimensions, specifications and ordering instructions.
Eclipse Fuel Engineering Company, Boiler Div, Manufacturers Rd. & Compress St., Chattanooga 5, Tenn.

Damper Actuators. Describing and showing how to install motorized Zone-A-Trol Damper Actuators is four-page Catalog ZDA-161. Units may be installed in new or existing residential or commercial air heating or cooling systems to control flow of air to each room or zone. Also covered is an air pressure dumper, which is used to control excess air volume and velocity on zone controlled air systems.
Econo Products Company Div, Viking Instruments, Inc., East Haddam, Conn.

Marine Insulation. Four-page Bulletin F107 is descriptive of NAV-hull Board, thermal and acoustical marine insulation made of glass fiber. Three types of insulation are discussed: thermal plain and faced and perforated acoustical. Installation methods are detailed and a type-and-size availability chart is included.
Fibrous Glass Products, Inc., a subsidiary of Pall Corporation, Alpa Plaza, Hicksville, N. Y.

Diffusers. Announced in eight-page Catalog RJ100 is a series of extruded aluminum, cylinder type, Roto-Jet diffusers for heating and cooling applications in any large interior where long projection of air or modulated diffusion is required. Incorporated in the design are a rotary cylinder and split diffusing vanes. Units can be installed either in a horizontal or a vertical position. Given in the catalog are performance data, dimensions and suggested applications.
Air Devices Inc., 185 Madison Ave., New York, N. Y.

COMING IN THE AUGUST ISSUE——NEWS REPORT OF THE DENVER MEETING

REVISION TO COIL STANDARD

A. T. BOGGS, III

ASHRAE Technical Secretary

The Society standard covering the testing and rating of air cooling and air heating coils was adopted as a joint standard of ASRE and ASHAE in 1958. In order to bring this standard in line with present Society standards policy and make it meet present industry requirements in this field, a project committee has been appointed to initiate a revision.

ARI: Three new standards consolidating and updating a number of existing standards have been published recently by ARI. The new standards are: (1) **450-61, Water-Cooled Refrigerant Condensers**—This Standard supersedes tentative standards 4-82 and 4-54 (1953) Construction of Ammonia Condensers, 4-62 (1953) "Freon" Water Cooled Condensers, and pertinent parts of 4-53 and 4-55 (1953) Performance of Ammonia Condensers, and 4-81 (1953) Application of Heat Transfer Equipment. (2) **480-61, Refrigerant-Cooled Liquid Coolers, Remote Type**— This Standard supersedes tentative standards 4-71, 4-72, and 4-76 (1953) titled Water and Brine Coolers, and pertinent parts of 4-81 (1953), Application of Refrigerant Heat Transfer Equipment. (3) **495-61, Refrigerant Liquid Receivers**—This standard supersedes Standards 4-56 (1953) Ammonia Liquid Receivers, and 4-63 (1953) "Freon" Liquid Receivers. Copies of the new standards are available from ARI, 1346 Connecticut Ave., NW, Washington 6, D. C. Standards 450 and 480 are priced at 75c each, and 495 at 35c.

ASA: The American Standard Specification for **General-Purpose Sound Level Meters (S1.4-1961)** is now available from ASA at $1.30 each. This standard, sponsored by the Acoustical Society of America, covers sound level meters and their calibration. The purpose of the standard is to insure maximum practical accuracy in sound level metering and to reduce to the lowest practical minimum any differ-

Presently Available Standards

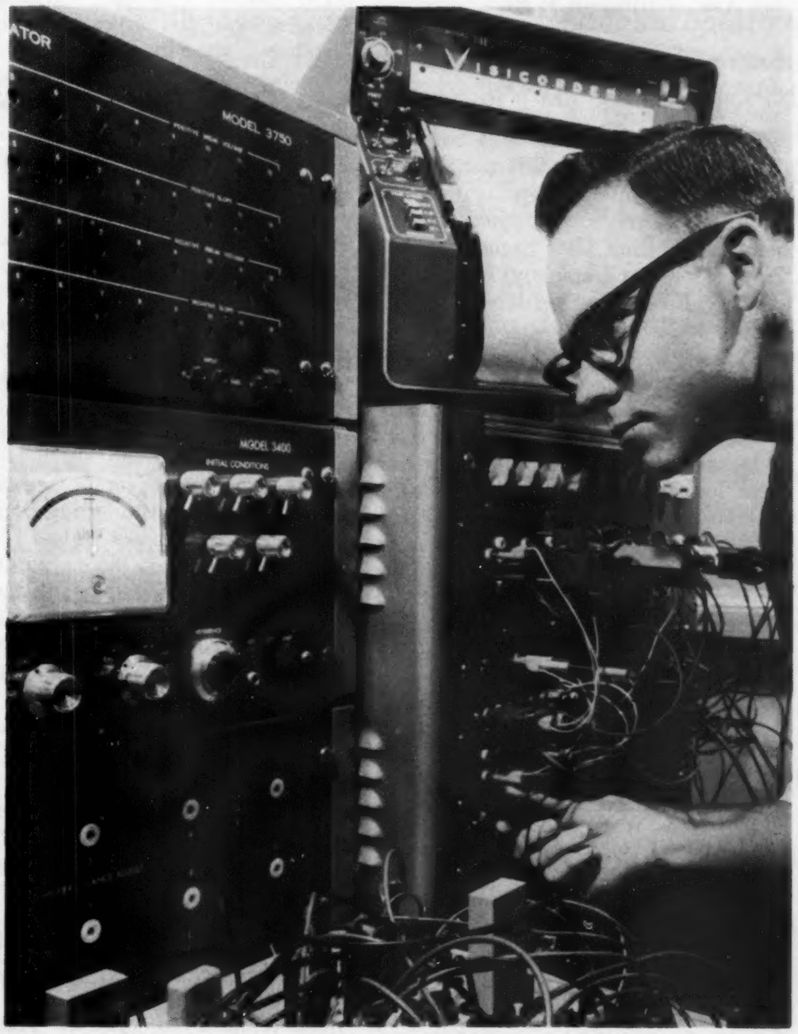
Copies of the following standards may be obtained from the ASHRAE Sales Department at the listed prices. A complete set of all standards is available at $10.

#12-58	Refrigeration Terms and Definitions (ASA B53-1958)	$1.25
#13-58	Home Freezers, Methods of Rating and Testing (ASA B38.3-1955)	.75
	Household Refrigerators, Method of Computing Food Storage Volume and Shelf Area of Automatic (ASA B38.1-1955)	.35
	Household Electric Refrigerators (Mechanically Operated) Test Procedures (ASA B38.2-1956)	.75
#14-59	Condensing Units, Mechanical, Methods of Testing for Rating	1.00
#15-58	Safety Code for Mechanical Refrigeration (ASA B9.1-1958)	1.00
#17-48	Expansion Valves, Refrigerant, Methods of Rating and Testing (ASA B60.1-1950)	1.00
#18-56	Drinking Water Coolers, Self-Contained Mechanically-Refrigerated, Methods of Rating and Testing	.75
#20-60	Evaporative Condensers, Remote Mechanical-Draft Air-Cooled, Methods of Testing for Rating	.75
#22-61	Water-Cooled Refrigerant Condensers, Methods of Testing for Rating	.75
#23-59	Compressors, Refrigerant, Methods of Testing for Rating	1.00
#24-61	Liquid Coolers, Methods of Testing for Rating	.75
#25-56	Air Coolers for Refrigeration, Methods of Rating	1.00
#26-56	Mechanical Refrigeration Installations on Shipboard, Recommended Practice for (ASA B59.1-1958)	1.25
#28-57	Capillary Tubes, Method for Testing	.50
#29-56	Ice Makers, Methods of Rating and Testing	.75
#30-60	Liquid Chilling Packages, Methods of Testing for Rating	.50
#32-57	Bottled Beverage Coolers, Methods of Rating and Testing	.75
#33-58	Air-Cooling and Air-Heating Coils, Forced Circulation, Methods of Testing and Rating	1.00
#34-57	Refrigerants, Number Designation of (ASA B79.1-1960)	.75
#35A-56	Desiccants for Refrigerant Drying, Method of Testing	.75
#35B-56	Driers, High Side Liquid-Line, Methods of Rating and Testing	1.00
#37-60	Unitary Air Conditioning Equipment, Methods of Testing for Rating	1.00
#38-57	Cooling Towers, Mechanical Draft, Methods of Testing for Rating under Controlled Conditions	.75
#40-61	Unitary Air Conditioning Equipment for Cooling, Heat Operated, Methods of Testing for Rating	1.50
#45-55	Heavy Duty Furnaces and Direct-Fired Unit Heaters, Code for Testing and Rating	.50
#47-60	Return-Line Low-Vacuum Heating Pumps, Method of Testing and Rating	.50

ences in corresponding readings with various makes and models of materials meeting the standard.

Bureau of Standards: The Bureau of Standards has announced availability of Miscellaneous Publication 233 on Units of Weights and Measures, including definitions and tables of equivalents. Copies are available from the Superintendent of Documents, Washington 25, D. C., at 40c each.

ASTM: Recent announcement from ASTM indicates the availability of the 1960 supplements to the 1958 Book of ASTM Standards. Each part-supplement brings up to date the corresponding part of the 1958 Book of Standards and 1959 supplement by including new standards and revisions adopted in 1960. The Book of Standards and its supplements contain over 2700 standard specifications, methods of test, recommended practices and definitions of terms for materials. Supplements to the ten parts of the Book of Standards are available from ASTM at $4 per part, or $40 per set.



COMPUTER EVALUATES AIR CONDITIONING CONTROLS PERFORMANCE AT ANY LOCATION

Ability to duplicate performance conditions at literally any place in the world is one of the requirements of Minneapolis-Honeywell engineers. With this analog computer, Research Engineer Donald Nelson can obtain in 15 minutes technical data that would otherwise take years to assemble.

Computer inputs simulate outdoor temperatures, wind direction and velocity, diurnal solar variations, latitude and whether the sun is shining or covered by clouds. Information fed into the computer includes building size, type of construction, glass area, insulation, air-conditioning requirements, piping and ductwork.

Results are used to evaluate performance capabilities of new temperature controls.

IHVE INTERNATIONAL CONFERENCE

Final program for an International Conference on Heating, Ventilating and Air Conditioning, as organized by The Institution of Heating and Ventilating Engineers, features three basic themes. These will be: administrative advances likely in the next ten years; technical advances probable in the same interval; and integrated design of architectural and engineering services for economy of building construction. The Conference will be held September 27-October 4 in the Empire Hall, Olympia, London, England.

Opened by President F. M. H. Taylor of IHVE, the development of the several themes will proceed first with a Symposium on Training and Education, papers upon cost accounting and research and technical visits to notable buildings.

The second theme, that of probable technical trends, will be developed by several speakers, including ASHRAE Presidential Member Burgess H. Jennings, formerly Director of Research at the ASHRAE Laboratory and now Professor at Northwestern University. Technical visits to seven notable installations, with special emphasis upon hospitals and public areas have been arranged.

The third theme, that of integrated design, has been related to urban planning, industrial buildings and engineering services. One of the speakers will be A. L. Jaros, Jr., on the topic of Economic Design for Office Buildings and their Services. Author Jaros contributed "Influence of Unshaded Window Area on Selection of Peripheral Air Conditioning Systems" to the January 1961 issue of the JOURNAL.

Numerous social events, including cultural, historic and similar side trips, as well as banquets and shows, have been arranged.

BULLETINS AND CATALOGS

Range Hoods, Ventilating Fans. Coverange kitchen hoods, the subject of 16-page Catalog 6479, are available with or without impeller-type blowers, propeller-type fans and lights and in either stainless steel, coppertone or white enamel finish. Also shown in the bulletin is a line of ventilating fans. Specifications and installation drawings are given for all wall and ceiling models. Available accessories are listed.
Philip Carey Manufacturing Company, Miami Cabinet Div, Middletown, Ohio.

Environmental Enclosures. Engineered to meet specifications for extra-clean assembly, testing, repair and packing, Packaged Environments provides removal of airborne contaminations to 0.5 micron, temperature control to ± ½ F and humidity control to ± 2% relative. Featured are modular insulated steel panel construction and packaged accessories; low heat loss, inert polystyrene insulation; weather-tight panels and joints permitting installation outdoors or inside; and capacity for enlargement. A 16-page bulletin contains descriptive information.
Moore & Hanks Company, 9702 E. Rush St., El Monte, Calif.

Performance Charts. Revised and expanded fan performance charts for standard sizes of air handling, multizone and heating-ventilating units are offered as Catalog 50Cla. Plotted are performance of forward and backward curved fans for ½ through 6-in. static pressure in the range of 400 to 800 fpm.
Recold Corporation, 7250 E. Slauson Ave., Los Angeles 22, Calif.

Flow Characteristics. Two methods for determining flow characteristics of this company's line of valves are described in 20-page Bulletin V-602. Covered in Section 1 is a fundamental method for determining pressure drops for all types and sizes of lubricated plug valves, including the venturi types. General instructions show how to use data from accompanying pressure drop tables. Section 2 offers a rapid method of estimating pressure drop through venturi-type valves. Corrections for different conditions of gas and liquid flow can be computed from examples given at the end of this section.
Rockwell Manufacturing Company, Nordstrom Valve Div, 390 N. Lexington Ave., Pittsburgh 8, Pa.

Switches. Specifications, details and dimensional diagrams for low pressure and velocity actuated flow switches are presented in a 30-page catalog. Included are vacuum, differential pressure, air flow interlock and water flow interlock switches, flow meters, manometers and air filter gages.
Henry G. Dietz Company, Inc., 12-16 Astoria Blvd., Long Island City 2, New York.

Heat Gain and Loss Calculator. Printed on plastics-coated, heavy gauge card stock and perforated for insertion in a looseleaf binder, this calculator has heat loss on one side and heat gain on the other. Designed primarily for whole-house estimates of what size and type of heating and cooling equipment is necessary, it may be used also for single room estimates. Complementing the calculator is a work pad containing cooling and heating estimating forms, both on the same sheet of paper. The back of each sheet is printed in graph form for drawing floor plans.
Fedders Corporation, 58-01 Grand Ave., Maspeth 78, N. Y.

Tubular Mufflers. Four-page Bulletin STM catalogs tubular mufflers for silencing gas discharges and intakes. Extensive acoustic and airflow performance data are included. Sizes for connection to pipes of from four to forty in. diam are listed.
Silence, Inc., P. O. Box 21, Farmingdale, N. Y.

Load Calculation. In the 94-page Comfort Guide Manual, summer load factors are combined in a single table for each principal type of window glass, with factors for various facings and times of day given for each of eight kinds of shading (shades half-drawn, shades or drapes fully drawn, fully-shaded overhang, skylight and others). Five geographic zones, 30 through 50-deg latitude, are detailed. Similar tables cover glass block, walls, roofs, ceilings, floors, partitions, people, appliances and ventilation air. Also included are appendix tables on such items as simplified air volume calculations, heat removal, building materials lag and shade factors.
Arkla Air Conditioning Corporation, 812 Main St., Little Rock, Ark.

Flooded Bed Scrubber. For elimination of fumes, vapors, mists and light dusts from collection systems, this unit is described in four-page Bulletin 160. Operating procedure and specific applications are outlined and dimensional data are provided in tabular form.
John Wood Company, Air Pollution Control Div, Bernardsville, N. J.

Properties of Glass. Extensive data on corrosion resistance and thermal expansion of 32 commercial glasses are major additions to a revised booklet, 16-page Bulletin B-83. Given for use in sealing applications is the average expansion coefficient from room temperature to the setting point of the glasses. A numerical code system shows the resistance of each glass to weather, water and acid. Information on evaluating the hardness of glass
(*Continued on page* 98)

WHO'S WHO IN ASHRAE

Insofar as possible these listings will each appear twice a year

ASHRAE OFFICERS, DIRECTORS COMMITTEES, STAFF
See page 94, June JOURNAL

REGION AND CHAPTER OFFICERS
See page 80, March JOURNAL

RESEARCH AND TECHNICAL COMMITTEES
See page 67, September JOURNAL

STANDARDS PROJECTS
See page 74, January JOURNAL

INTER SOCIETY COMMITTEES
See page 84, November JOURNAL

HEAT GAINS BY DUCTS REQUIRE INCLUSION OF SPECIAL TEMPERATURE CALCULATIONS PAGE 59

HUMIDITY CONTROL DOMINATES THIS AIR CONDITIONING SYSTEM PAGE 67

Tucson is Fourth Chapter to Achieve its UEC Quota

"We are very proud to have been able to do our small share in support of the financing for the United Engineering Center Building."

With these words, Richard E. Joachim, chairman of the ASHRAE-UEC Fund Raising Campaign for the Tucson Chapter, notified the Society of his Chapter's success in exceeding its quota. The goal for the 59-member Tucson Chapter was $885. The amount raised in little more than five months was $896.65. Twenty-four members contributed $615.00; the Chapter pledged $281.65 from its treasury.

Tucson is now the fourth ASHRAE chapter to achieve its UEC quota, and the first to do so from Region X. The other successful chapters are Central Oklahoma—Region VIII (ASHRAE JOURNAL, June 1960, Page 59); South Piedmont—Region IV (ASHRAE JOURNAL, October 1960, Page 80); and Toledo—Region V (ASHRAE JOURNAL, March 1961, Page 78).

Significantly, all of these chapters are far distant from New York and none of them has a membership as large as 120. Most important, each of these chapters has excellent leadership and each regards seriously its professional responsibility.

Raising money for a worthy cause is not the moral obligation of any single person or committee. No matter how dedicated and industrious the responsible fund raiser, a fund-raising campaign depends for its success upon contributions and support by many.

The four chapters which fulfilled their quotas had ardent and hard-working men in charge of their campaigns and members conscious of pride in their chapters, pride in their Society and pride in contributing a share in building a monument to their—the engineering—profession.

As of June 1, ASHRAE had raised $43,000 towards our pledged quota of $250,000. Seventy-eight Chapters have organized fund raising campaigns and appointed chairmen; there are still 10 delinquent Chapters.

The new United Engineering Center is rapidly nearing completion and the staffs of 19 engineering societies, including ASHRAE, are looking forward to relocating in this building by September.

HAVE YOU DONE YOUR SHARE IN BUILDING THIS ENGINEERING SYMBOL?

NAME ....

ADDRESS ....

IN CONSIDERATION OF THE GIFTS OF OTHERS INTENDS TO GIVE TO

UNITED ENGINEERING CENTER BUILDING FUND

.................................DOLLARS $........

BALANCE TO BE PAID QUARTERLY $........, SEMIANNUALLY $........

ANNUALLY $............, OR AS FOLLOWS ....

SIGNED..

MEMBER ASHRAE

CHECK MAY BE MADE PAYABLE TO UNITED ENGINEERING TRUSTEES, INC.
29 WEST 39TH STREET, NEW YORK 18, N. Y.
GIFTS ARE DEDUCTIBLE FOR INCOME TAX PURPOSES

Gruppo Italiano Holds Second Exhibition and Meeting

Combining its second exhibition of Heating, Air Conditioning, Refrigeration and Hydrosanitation with its Second Air Conditioning Meeting, the ASHRAE Italian Branch held a three-day conclave early in March. It is estimated that 300 attended the Technical Sessions; 12,000 the commercial exhibit. Both were in Milano at Cicogna's Hall. There were 85 exhibitors.

AT THE TECHNICAL SESSIONS

President Gian Felice Bertolini opened the assembly with a reminder of the 1957 International Meeting on Air Pollution in Milano and urged legal backing for control. The topic is scheduled for one meeting annually there.

There were three basic subjects covered at the technical sessions: Air Conditioning and Ventilation; New Heating Methods and Equipment; and, Air Conditioning and Refrigeration Plants of 1960 in Italy. Industrial speakers touched upon such details as: Aerosol filtering, mechanical filtering, electrostatic filtering and catalysts; coal and oil burners, liquid additives and better combustion techniques; specific and individual installations of air conditioning.

Active in the program planning were: President Bertolini, the vice presidents, President R. A. Goerg (Swiss Group), G. Levantal (Delegate, Association pour la Prevention de la Pollution Atmospherique), P. Lassere (Technical Manager, Centre d'Information pour le Developpement du Conditionnement d'Air et du Depoussierage), Technical Secretary E. Gherarducci and General Secretary G. du Bot.

A view of the exhibit area

Cicogna's Hall at the Milano International Fair Quarter

THINGS TO CONSIDER WHEN SELECTING MTW EQUIPMENT PAGE 44

BULLETINS

(*Continued from page* 88)

also is given. Included are standard sections on mechanical, electrical and optical properties; thermal stress; heat transmission and viscosity.
Corning Glass Works, Corning, N. Y.

Product Lines. Discussing the history, products and future capabilities of this company, the Image, a 12-page booklet, presents extensive photographic and descriptive material. Produced by this manufacturer are compound semiconductors, thermoelectric modules and various control mechanisms.
Ohio Semiconductors Div, Tecumseh Products Corporation, 1205 Chesapeake Ave., Columbus 12, Mo.

Insulating Firebrick. Contained in 36-page Bulletin R-38 are an extensive discussion of the advantages of insulating firebrick and charted information on a wide variety of applications. Included are drawings of constructions and basic application and selection data, such as heat loss and storage tables.
Babcock & Wilcox Company, Refractories Div, 161 E. 42nd St., New York 17, N. Y.

Filter Driers. Extensive tabular data in six-page Bulletin 276-A include nominal capacity in ton, size and type connection, body diam, depth of filter area, dimensions, pressure drop and drying capacity of this line of sealed-type, molecular sieve filter driers. Units are available in many different types; can be used with Refrigerants 12, 22 or 500; and can remove and retain up to 20% of their weight in water at 140 F or higher, holding moisture concentrations in the refrigerant to 10 ppm or below.
American-Standard, Controls Div, 5900 Trumbull Ave., Detroit 8, Mich.

Air-Cooled Condensers. Illustrated with photographs, four-page Bulletin DB-2232 covers significant features of these condensers, which are available in two models, either for horizontal or vertical air flow. Coil design is cited as making possible smaller refrigerant charge requirements.
Westinghouse Electric Corporation, Air Conditioning Div, Staunton, Va.

Three-Pass Boilers. Available for low or high pressure steam or hot water and designed for burning gas, oil or combination fuels, these three-pass packaged boilers, with forced draft design, range from 15 to 500 hp.

Featured are front-end cleaning without disturbing the burner or fuel piping, a rear access door for inspection without removing the entire rear plate, elimination of horizontal refractory baffles, large furnace volume for quiet operation and five sq ft of heating surface per boiler hp. Bulletin 601 describes additional features.
Arkos Manufacturing Company Div, Arnold A. Kosarin & Associates, Inc., Detroit, Mich.

Buyers' Guide. Discussed in a 16-page bulletin are heating and air conditioning problems. Various units in the 365 Conditionair Line are described. Material is included on oil and gas-fired equipment, heat pumps, remote control cooling systems and packaged attic-type air conditioning units.
Delco Appliance Div, General Motors Corporation, P. O. Box 230, Rochester 1, N. Y.

Corrosion Protection. Covering Stackfas, a product designed to resist acid corrosion from high sulphur fuels, Bulletin SF is comprised of charts showing testing methods and results for this coating, scale diagrams of various types of chimney construction and photographs showing methods of application.
Amchem Products, Inc., Benjamin Foster Company Div, 4635 W. Girard Ave., Philadelphia 31, Pa.

Replacement Filter. For use in air conditioning, heating, air handling and processing systems, Cube-Type Replacement Filters are the subject of four-page Bulletin B1. Illustrations show the filter's four main components: inside retainer, Dynel modacrylic filter, holding frame and outside retainer. Listed in a data table are face area, depth, capacity and resistance of more than a dozen filter sizes.
Union Carbide Development Company Div, Union Carbide Corporation, 270 Park Ave., New York 17, New York.

Combustion Analyzer. Described in six-page Bulletin V588, this portable, electronic combustion analyzer utilizes bead-type thermistors cited as being unaffected by soot or other foreign matter. Operation of the unit is through measurement of the CO_2 content of flue gas, stack temperature and draft over fire. Photographs, diagrams and ordering information are included.
Victory Engineering Corporation, Box 373, Union, N. J.

Storage Water Heaters. Eight-page Bulletin 1234 lists storage and heating capacities, dimensions and material thicknesses for vertical and horizontal water heaters of plain steel, copper silicon, copper-lined and Pre-Krete lined. Information is provided in a separate section for a new Scalefree 230, indirect gas-fired storage water heater, a packaged unit with storage capacities from 250 to 4000 gal and recovery capacities from 390,000 to 2,215,000 Btu/hr.
Patterson-Kelley Company, Inc., East Stroudsburg, Pa.

Replacement Motors. Air conditioning replacement motors for units from 1/3 through 3 ton are described in a four-page bulletin. Extensive performance data are included, together with dimensional diagrams and photographs.
Redmond Company, Inc., Owosso, Michigan.

Air Distribution System. A new low velocity method of introducing conditioned air into a room through perforated metal bar diffusers integral with the ceiling, the Acousti-Flo System is discussed in 12-page Bulletin 1-AC-1385-B. Conditioned air is guided down the length of the bar by glass fiber tube, cited as absorbing

New Crown Zellerbach Building

San Francisco

Modular Design Provides Maximum Flexibility of Office Space Layout

Hertzka & Knowles and Skidmore, Owings & Merrill
Associated Architects

Haas and Haynie
General Contractor

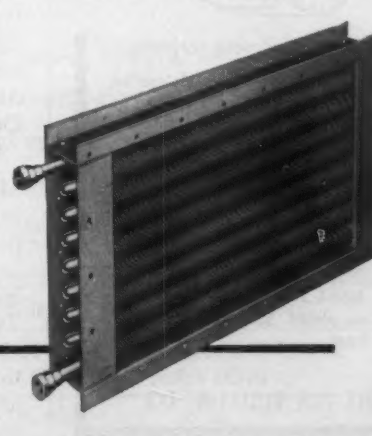
McClenahan Company
Heating, Plumbing, Air Conditioning

AEROFIN INSTALLED

Modern smooth-fin design of Aerofin coils permits ample heat-exchange capacity in limited space—permits the use of high velocities without turbulence or excessive resistance.

Aerofin performance data are laboratory and field proved. You can safely specify Aerofin coils at full published ratings.

Type C Water Coils used for both heating and cooling



More than 300 hot water reheat coils throughout the building provide zone heating

AEROFIN CORPORATION

101 Greenway Ave., Syracuse 3, N.Y.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

ENGINEERING OFFICES IN PRINCIPAL CITIES

system noise and insulating against heat loss or gain. Charts and diagrams supplement the text.
Owens-Corning Fiberglas Corporation, Industrial Construction Material Div, 717 Fifth Ave., New York 22, N.Y.

Protective Coating. Described in an eight-page bulletin is the Niphos Process, a method of applying protective, firmly bonded metallic coatings to tubing and pipe fittings without the use of electric current. Coatings of nickel and phosphorous compounds, copper, cobalt, molybdenum and other metallic alloys are obtainable.
M. L. Sheldon & Company, Inc., 350 Lexington Ave., New York 16, N.Y.

Metalized Plastics Sampler. Showing a line of metalized polyester film, this sampler includes 33 examples of colored plastics, embossed patterns and specialties such as perforated, flocked and pressure sensitive backed laminations. Many applications are cited, with technical data provided.
Coating Products, Inc., 101 W. Forest Ave., Englewood, N. J.

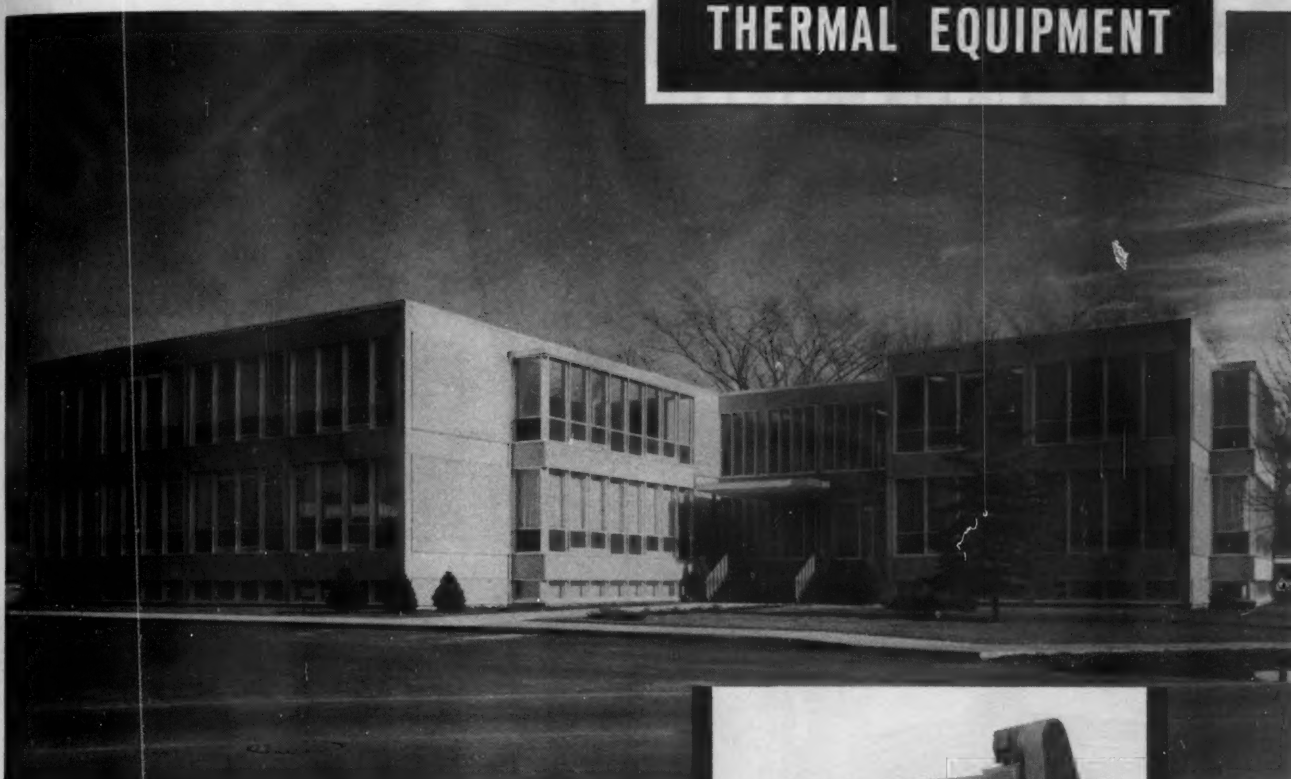
Electronic Air Cleaner. Discussed in 12-page Bulletin 57-4002 are details of this manufacturer's newly developed electronic air cleaner with an activated charcoal filter. An analysis of equipment and operating costs is presented and features of the unit are given.
Minneapolis-Honeywell Regulator Company, 2753 Fourth Ave. S., Minneapolis 8, Minn.

Boilers. Eight-page Bulletin 649B describes Kewanee Type C boilers for low pressure heating of commercial and industrial buildings. Included are tabular data on ratings and dimensions of these units, which are available in 16 sizes ranging in capacity from 1,392,000 to 15,430,000 Btu/hr. Covered also are features, typical specifications and selection data for available heating coils and induced draft fans.
American-Standard, Industrial Div, Detroit 32, Mich.

Motor Application Guide. Described in 16-page Bulletin 010 is this company's line of single and three-phase and dc motors. Gearmotors and selective speed drives also are included. Two motor selection charts are provided for matching motor characteristics to specific applications for single and polyphase and dc motors. Rating and dimension tables are given.
Century Electric Company, 1806 Pine St., St. Louis 3, Mo.

MORE

COMFORT...
DEPENDABILITY...
EFFICIENCY
WITH ALL FORMS OF
THERMAL EQUIPMENT



Consulting Engineer: Charles R. McDonald, Arlington Heights, Ill.
Thermal Agent: Barr and O'Dwyer, Chicago, Ill.

Vertical
Central Plant

Moore Business Forms, Inc., Relies on Thermal In Its Park Ridge, Illinois Offices . . .

for a dependable, long-life air conditioning and heating system, to deliver pleasant year-round comfort. From North to South and East to West—business offices and other structures are using the Thermal line of superior air conditioning and ventilating equipment to assure comfort and satisfaction. Its rugged construction warrants dependability and long life.

Thermal's wide range of sizes and models of cooling, heating and ventilating equipment permits tailoring the system to climatic and architectural requirements. The Thermal line includes central plant and multizone conditioners, sprayed coil units, heating and ventilating units, heating and cooling coils and air-cooled condensers. For further information on air conditioning and ventilating equipment you can specify with confidence, write for complete catalog and names of nationally known concerns using Thermal.

Quality Products Since 1945

THERMAL ENGINEERING CORPORATION

2605 W. DALLAS • P. O. BOX 13254
HOUSTON 19, TEXAS

AGENTS IN PRINCIPAL CITIES

Range Hoods, Ventilating Fans. Illustrations, installation drawings and specifications are provided by 16-page Bulletin 298-L for each range hood and ventilating fan in this line. Changes in the line include: new series of duct-free hoods, high pressure hoods featuring top or back outlet and higher-capacity economy hoods.
Air Control Products, Inc., Leigh Building Products Div, Coopersville, Michigan.

Compact Valves. Four standard space-saving expansion valves designed for refrigeration and air conditioning, in either original equipment installations or for replacement purposes, are illustrated pictorially and schematically in six-page Bulletin 262-B. Product features are detailed and a Direct Replacement Chart lists valves replaceable by Model 900 without repiping.
American-Standard, Controls Div, 5900 Trumbull Ave., Detroit 8, Mich.

Pipe Dimension Chart. Shown on this 17 x 11-in. chart are outside diam and wall thickness for all sizes of pipe from ½ through 42 in. Included is information from ASA Standard B36.10, showing IPS and schedule numbers and their relationship.
Crane Company, Midwest Piping Div, Box 433, St. Louis 66, Mo.

Slide Rule. Cited as simplifying the task of sizing control valves for known conditions of flow and pressure, this slide rule solves for C_v and corrects for steam quality, gas specific gravity and temperature, and liquid specific gravity and viscosity. Standard slide-rule scales A, B, C and D are incorporated and step-by-step instructions are provided.
Robertshaw-Fulton Controls Company, Fulton Sylphon Div, Box 400, Knoxville 1, Tenn.

Refrigerated Dryers. Three self-contained refrigerated, compressed air dryers are discussed in Flyer 610: Models 101, 250 and 350, with capacities of 10, 25 and 35 cfm, respectively, at 100 psig. Technical information is given for each unit and piping layouts are shown.
Zeks Industries, Inc., West Chester Pike & Providence Rd., Edgemont, Pennsylvania.

Pressure Regulators. Sliding gate pressure regulators are the subject of eight-page Bulletin J169-1. Diagrams of various models key to lists of component parts, and features, operation and construction are covered in detail.
OPW-Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.